Estimates of fish, spill and sluiceway passage efficiencies of radio-tagged juvenile salmonids relative to operation of the Sluiceway Guidance Improvement Device at The Dalles Dam in 2002

Final Report of Research during 2002

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Executive Summary

In 2002, the U.S. Army Corps of Engineers (COE) contracted with the U.S. Geological Survey to determine the effect of the Sluiceway Guidance Improvement Device (SGID) on spillway, sluiceway, and fish passage efficiencies at The Dalles Dam (TDA) during a 40% continuous spill treatment. The SGIDs are a series of steel plates designed to occlude the upper portion of the turbine intakes. The SGIDs at main units 1 through 4 were used in the "in" and "out" treatments, hereafter referred to as the occluded and unoccluded treatments, respectively. Our specific objectives were to: 1) determine the proportion of radio-tagged wild juvenile steelhead (*Oncorhynchus mykiss*) and yearling Chinook salmon (*O. tshawytscha*) that passed through the spillway, sluiceway, and powerhouse at TDA under either occluded or unoccluded conditions and 2) obtain information on the behavior of radio-tagged fish in the near-dam area prior to passage. The SGIDs were only tested on main units 1 through 4 (MU1-MU4) so some analyses are presented for all fish released, for only those detected at MU1-MU4, or for both where appropriate. There was a telemetry equipment failure at MU4 during the spring study period so data pertaining to the test units during this period include MU1-MU3 only.

Dam Operations: The test condition was similar to that proposed. Mean hourly percent spill during the spring study period was 37.1% during the day and 40.4% at night. Mean hourly percent spill during the summer study period was 36.0% during the day and 41.9% at night. Mean hourly total discharge ranged from 142 thousand cubic feet per second (KCFS) to 422

KCFS during the study spring period with means of 254 and 247 KCFS for the day and night, respectively. For the summer period, mean hourly total discharge ranged from 135 to 466 KCFS with means of 285 and 262 KCFS, respectively.

Number of Fish Released and Detected: From 02 May through 07 June, we radio-tagged and released 2724 wild juvenile steelhead and 3043 yearling Chinook salmon. From 25 June through 13 July we tagged and released 4709 subyearling Chinook salmon. Release sites included: 1) Rock Creek, 23 km upstream from John Day Dam (JDA), 2) the JDA spillway, 3) the JDA juvenile bypass system outfall, and 4) the JDA tailrace for the spring study and the same release sites with the exception of the spillway for the summer study. The telemetry systems at TDA detected 84% of the juvenile steelhead, 80% of the yearling Chinook salmon, and 80% of the subyearling Chinook salmon released.

Travel Time, Arrival Time, and Approach Pattern: Median travel times of juvenile steelhead and yearling Chinook salmon from the Rock Creek release site to the TDA near-dam forebay were 61.8 and 46.2 h, respectively. Median travel times of juvenile steelhead and yearling Chinook salmon released in the JDA tailrace to TDA were 16.2 h and 19.6 h. The median travel time of subyearling Chinook salmon from the Rock Creek release site to the TDA near-dam forebay was 34 h and from the JDA tailrace to TDA was 14 h. Due to the release times and the variable length of time it took individual fish to reach the dam, the hour of arrival at TDA during both study periods was widely dispersed throughout the diel period. However, the peak arrival of steelhead and subyearling Chinook salmon occurred between approximately 1000 and 1800 hours. Yearling Chinook salmon showed no discernible peak in diel arrival times.

Most juvenile steelhead were first detected (i.e., approached the dam) at the spillway regardless of arrival time. An average of 64% of the juvenile steelhead arriving during the day (0700 to 1859 hours) were first detected at the spillway and 54% of those arriving at night (1900 to 0659 hours) were first detected in this area. Both yearling and subyearling Chinook salmon showed a similar pattern with more first detections occurring at the powerhouse during the day and more occurring at the spillway at night. An average of 52% of yearling and 64% of subyearling Chinook salmon arriving during the day were first detected at the powerhouse, and 63% of the yearlings and 56% of the subyearlings arriving at night were first detected at the spillway.

Forebay Residence Times: The median residence times in the near-dam forebay were less than 0.5 h for all fish detected. Median residence times ranged from 0.2 to 0.5 h for juvenile steelhead, from 0.1 to 0.2 h for yearling Chinook salmon, and from 0.02 to 0.1 h for subyearling Chinook salmon. For only those fish detected at MU1-MU4, residence times were always longer during the occluded treatment than during the unoccluded treatment. Juvenile steelhead had residence times of 0.5 h for the occluded treatment and 0.3 h for the unoccluded treatment during the day and 0.3 h for both the occluded and unoccluded treatments at night. Yearling Chinook salmon had residence times of 0.4 h for the occluded treatment and 0.2 h for the unoccluded treatment during the day and 0.3 h and 0.2 h for the occluded and unoccluded treatments, respectively, at night. Subyearling Chinook salmon had residence times of 0.3 h for the occluded treatment and 0.2 h for the unoccluded treatment during the day and 0.2 h and 0.1 h for the occluded and unoccluded treatments, respectively, at night. Residence times were generally longer during the day regardless of treatment.

Fish, Spill, and Sluiceway Passage Efficiencies: Most fish of each species passed the dam via the spillway. Powerhouse (turbine) passage was the second most prevalent route except for juvenile steelhead whose second most prevalent route of passage was the sluiceway. The juvenile steelhead fish passage efficiency (FPE) estimate was 90%, spillway passage efficiency (SPE) was 76%, and sluiceway passage efficiency (SLPE) was 14%. The FPE of yearling Chinook salmon was 70%, the SPE was 60%, and the SLPE was 10%. The FPE of subyearling Chinook salmon was 64%, the SPE was 56%, and the SLPE was 8%. These results are based on total fish detected and do not take into account the occluded and unoccluded treatments. The passage indices for all fish detected at MU1-MU4 by diel period and treatment show passage trends for each species (Executive Summary Table). All comparisons of treatments throughout this report were made using only those fish detected at the units testing the SGIDs (MU1-MU4). The results for the spring showed no significant difference between treatments of juvenile steelhead or yearling Chinook salmon FPE, SPE, or SLPE at night but did show a significant difference in SPE and SLPE of steelhead and FPE and SPE of yearling Chinook salmon during the day. During the summer study period, subyearling Chinook salmon FPE was significantly different between treatments during both day and night and SLPE was significantly different at night.

Spill Effectiveness: Spill effectiveness during the spring study period was 1.9:1 for juvenile steelhead and 1.5:1 for yearling Chinook salmon. The spill effectiveness for subyearling Chinook salmon during the summer study period was 1.4:1. These ratios are based on all fish detected and are presented for comparison to studies from previous years.

Executive Summary Table. The fish passage efficiency, spillway passage efficiency, and sluiceway passage efficiency of all study fish detected on antennas at MU1-MU4 by diel period and treatment at The Dalles Dam, 2002.

	Yearling Chinook		**Juvenile Steelhead**		**Subyearling Chinook**	
Fish Passage Efficiency (FPE)						
Treatment	FPE	95%CI	FPE	95%CI	FPE	95%CI
Occluded day	80.5	70.5-88.4	94.5	90.5-97.2	70.3	61.9-77.9
Unoccluded day	42.7	35.0-50.6	93.9	90.0-96.7	41.2	33.6-49.0
Occluded night	81.1	71.2-88.9	79.1	68.4-87.6	75.0	64.8-83.6
Unoccluded night	68.8	58.0-78.4	87.5	76.3-94.8	36.5	27.7-46.0
Spill Passage Efficiency (SPE)						
	SPE	95%CI	SPE	95%CI	SPE	95%CI
Occluded day	40.7	25.2-57.5	42.5	35.5-49.8	42.5	29.5-56.2
Unoccluded day	13.4	6.8-22.8	28.9	22.9-35.5	21.0	12.2-32.0
Occluded night	14.9	8.4-23.4	31.3	21.2-43.0	21.3	9.4-37.7
Unoccluded night	6.5	2.6-12.9	27.1	15.9-40.6	3.9	0.5-12.9
Sluiceway Passage Efficiency (SLPE)						
	SLPE	95%CI	SLPE	95%CI	SLPE	95%CI
Occluded day	39.8	31.5-48.6	51.9	44.7-59.2	27.8	20.5-36.0
Unoccluded day	29.3	23.9-35.0	65.0	58.2-71.4	20.2	14.5-26.9
Occluded night	94.5	55.0-76.3	47.8	36.1-59.6	53.8	42.8-64.4
Unoccluded night	93.9	51.2-72.6	60.4	46.3-73.4	32.7	24.2-42.1

Introduction

The regional fishery managers are exploring methods of increasing non-turbine passage at The Dalles Dam (TDA). Unlike most other hydroelectric dams operated by the U.S. Army Corps of Engineers on the Columbia River, TDA is not fitted with screens to divert fish from turbine passage. This is primarily due to the effectiveness of the existing spillway and ice-trash sluiceway, which have been used in combination to pass 80 to 90% of juvenile salmonids, depending on percent spill (Ploskey et al. 2001). The ice-trash sluiceway alone can pass approximately 40% of juvenile salmonids during periods without spill. Turbine passage is generally greater during the night than the day, ranging from about 5 to 20% depending on the time of day and year (Ploskey et al. 2001). For example, turbine passage estimates based on a hydroacoustic study in 2000 were 5% day/11% night during the spring and 16% day/21% night during the summer (Moursund et al. 2001). In 2002, turbine passage with and without a series of steel plates designed to occlude the upper portion of the turbine intakes were tested at several turbines (Figure 1). These plates, called sluiceway guidance improvement devices (SGID), were similar to those used in 1996 and identical to those used in 2001. Trash rack occlusions plates used in 1996 were flat and did not include the "J" extension.

In 2002, the U.S. Army Corps of Engineers (COE) contracted with the U.S. Geological Survey (USGS) to determine spill and fish passage efficiencies at TDA as part of an evaluation of SGIDs. Our specific objectives were to: 1) determine the proportion of radio-tagged juvenile steelhead (*O. mykiss*) and yearling and subyearling Chinook salmon (*O. tshawytscha*) that passed through the spillway, sluiceway and powerhouse at TDA during occluded and unoccluded treatments and 2) obtain information about the behavior of radio-tagged fish in the near-dam area prior to passage.

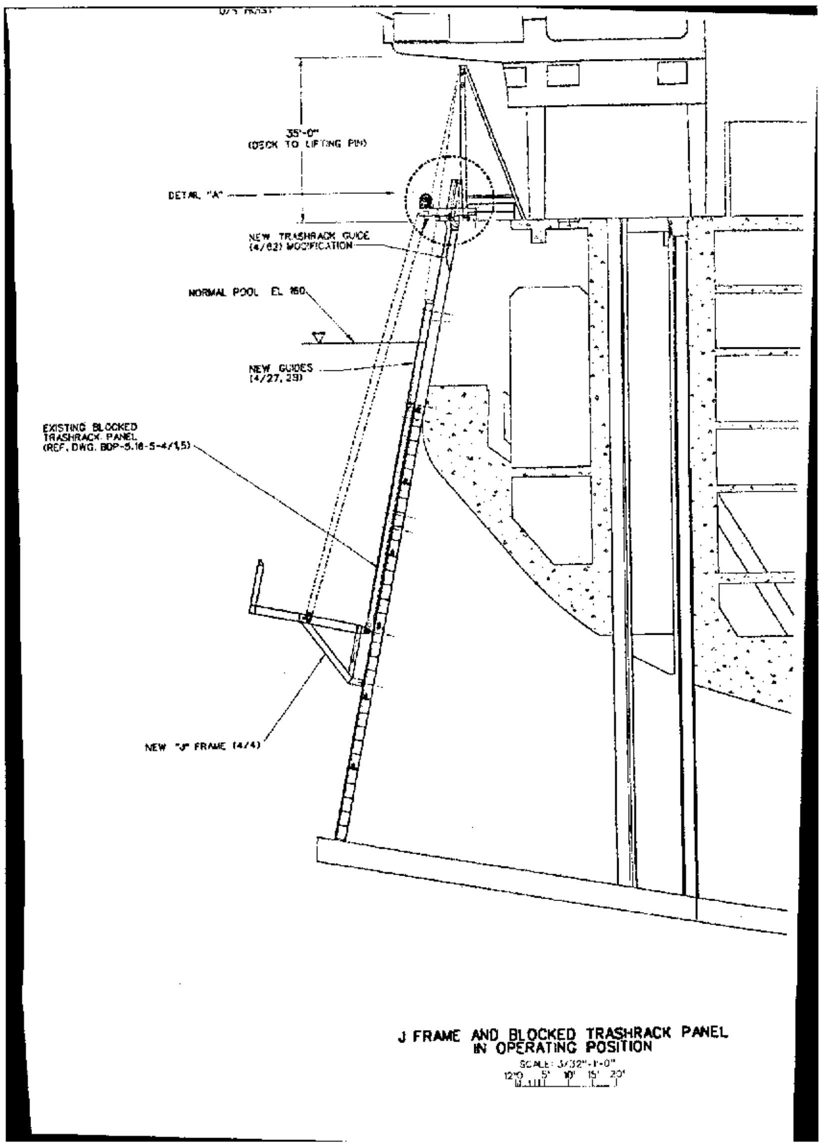

Figure 1. Schematic of typical SGID panel in "occluded" position. Schematic from U.S. Army Corps of Engineers "The Dalles Lock and Dam Blocked trash rack extension" plans dated 21 August 2000.

Methods

Study Site

The Dalles Dam is located on the Columbia River at river km 307 (Figure 2). The dam consists of a single powerhouse of 22 turbine units and a single spillway of 23 tainter gates. The

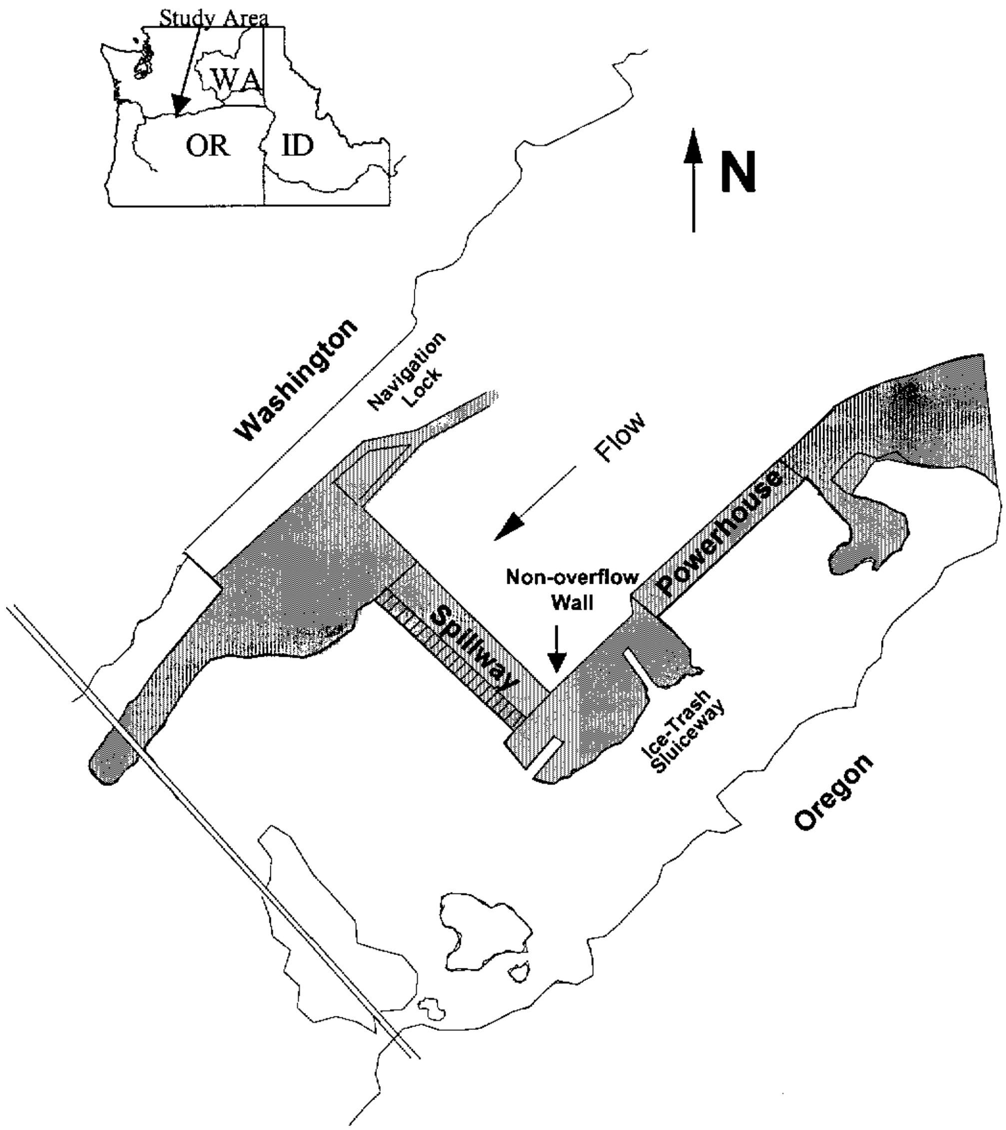

Figure 2. The Dalles Dam (river km 307) study site on the Columbia River and map indicating study site relative to the states of Washington (WA), Oregon (OR) and Idaho (ID).

powerhouse is oriented approximately perpendicular to the natural river thalweg, which turns southeast abruptly in the powerhouse area, continues along the powerhouse tailrace and passes under the Highway 197 bridge near the Washington shore. A non-overflow wall connects the powerhouse and spillway. A navigation lock is located at the northwest end of the dam.

Dam Operations

The SGIDs were installed at several turbine units at the west end of the powerhouse. They were installed in each of the three intake slots of main units 1 through 4, for a total of 12 SGID plates. In addition, "flat" trash rack occlusion plates, essentially SGIDs without the "J" extensions, were installed at the two intake slots at each of fish units 1 and 2. The SGIDs at main units 1 through 4 were used in the occluded and unoccluded treatments for this study. The trash rack occlusion plates in the intake slots of the fish units remained in the occluded position throughout the study.

Treatments lasting 3 d were alternated using a randomized block design beginning on 20 April 2002 and ending on 12 July 2002 for a total of seven 6-d study time periods during the spring and seven 6-d time periods in the summer (Appendices A and Q). These 6-d time periods will hereafter be referred to as blocks. Changes in treatments were planned to occur between 0800 and 1200 hours on the appropriate dates.

The study plan called for passing 40% of the total discharge through the spillway using the juvenile spill pattern. The juvenile spill pattern emphasizes spill through the northern spill bays to avoid directing fish to the shallow areas, rocks and islands on the south side of the tailrace. Juvenile salmonids in this southern area have prolonged tailrace residence times in an area known to harbor predators, such as the northern pikeminnow (*Ptychocheilus oregonensis*; Shively et al. 1996, Martinelli et al. 1997, Allen et al. In Review). The number of spill bays in use during this pattern depends on the total discharge. Spill bays are used as needed beginning with the north bays and proceeding south until the desired spill volume is achieved; the amount of spill per bay is higher in north than in south bays. Hourly powerhouse and spillway discharge data were obtained from the COE (2002) and compiled by Battelle Pacific Northwest Laboratories and USGS for each study period.

Telemetry Receiving Equipment

A system of aerial and underwater antennas was used to detect radio-tagged fish near TDA. Four-element Yagi (aerial) antennas were positioned along the forebay sides of the powerhouse and spillway to detect fish within about 100 m of the dam face, hereafter referred to as the near-dam area. Each aerial antenna monitored an area in front of a pair of turbine units or spill bays. Eight 4-element Yagi antennas were also placed evenly along the forebay side of the non-overflow wall. Aerial antennas at the powerhouse were aimed almost vertically downward toward the water surface to reduce their range to a maximum of 80 m from the dam to restrict the data collected from them to those fish that were nearest the powerhouse. The Yagi antennas were connected to SRX-400 receivers (Lotek Wireless, Newmarket, Ontario, Canada[1]), which recorded the telemetry data, following the methods of Hensleigh et al. (1999). Additional aerial antennas were used to monitor the tailrace and area near the upstream boundary of the forebay boat-restricted zone. Each SRX-400 receiver was configured to scan all attached antennas combined (the master antenna), until it received a signal and then cycle through individual aerial antennas (auxiliary antennas) to determine a more precise location of the transmitter.

Underwater dipole antennas were used to monitor radio-tagged juvenile salmonids within about 10 m of each turbine unit or spillway tainter gate (standard dipole antennas as described by Beeman et al. In Press). Underwater dipole antennas were mounted at several elevations to the main pier noses between all main units, main unit 1 and fish unit 1, and the pier nose to the west (downstream) of fish unit 2. The antennas were mounted at elevations 140, 120 and 100 ft above mean sea level (msl), which correspond to water depths of 20, 40, and 60 ft below the normal operating pool elevation of 160 ft above msl (Figure 3). The inputs from all underwater antennas, the two aerial antenna arrays in the sluiceway, and aerial corner-reflector antennas at the spillway tailrace were monitored using a Multiprotocol Integrated Telemetry Acquisition System (MITAS), which is a PC-based telemetry data collection system (Grant Systems Engineering, Collingwood, Ontario, Canada).

Fish Tagging, Handling, and Release

This study was based on radio-tagged wild steelhead, and yearling and subyearling Chinook salmon of primarily hatchery origin released as part of several concurrent studies at John Day Dam (JDA). The studies were designed to determine fish passage efficiency (FPE), tailrace egress times, and project survival at JDA. Tagged fish for those studies were released:

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1 Reference to trade names does not imply endorsement by the U.S. Government.

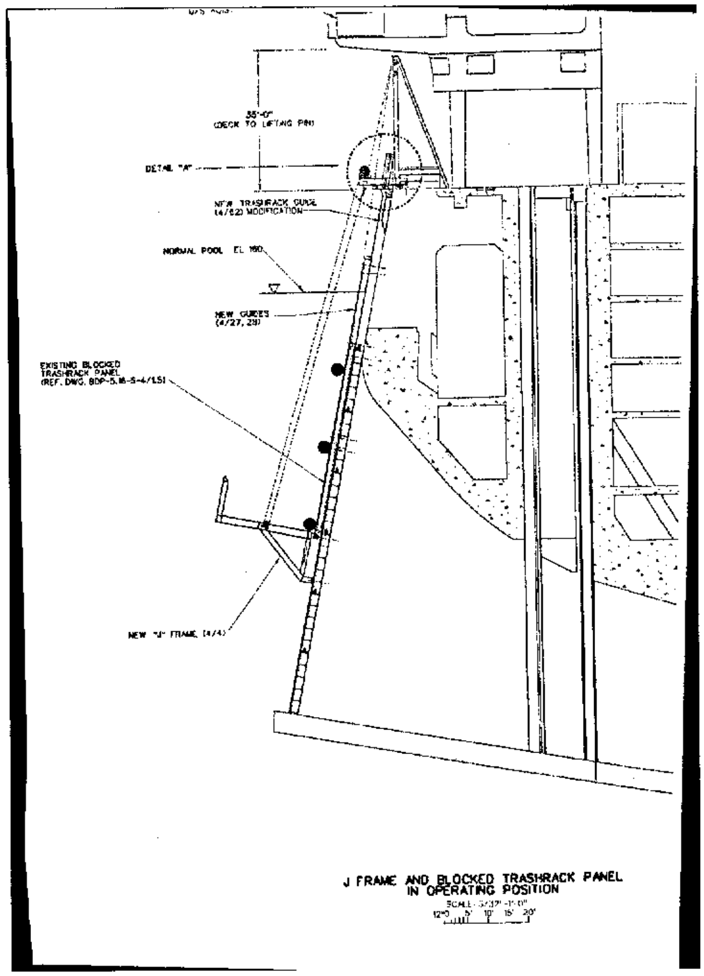

Figure 3. Schematic of typical SGID panel in "occluded" position with filled circles indicating underwater antenna locations. Original schematic from U.S. Army Corps of Engineers.

1) at Rock Creek (23 km upstream of JDA), 2) through flexible hoses near the ogee crest of several spill bays, 3) through the juvenile bypass system (JBS), and 4) in the JDA tailrace approximately 1 km below the dam. Releases at Rock Creek occurred at 0900 and 2100 hours, those in the JDA tailrace were at 1100 and 2300 hours, and those through the JBS occurred at 1100 and 2200 hours. Juvenile wild steelhead were released through the spillway at 1100 and 2200 hours, but no direct releases of yearling or subyearling Chinook salmon were made through the spillway. See Duran et al. (2002) and Beeman et al. (In Review) for further details of the fish releases at JDA. All fish to be implanted with radio transmitters were obtained through the

Smolt Monitoring Program at JDA. Fish to be implanted were typically held at the collection facility for 12 to 24-h prior to tagging. Fish were considered suitable for tagging if they were free of major injuries, severe descaling, external signs of gas bubble trauma, or other obvious abnormalities.

Pulse-coded transmitters operating at frequencies between 150.320 and 150.760 MHz were used to allow each individual fish to be recognized. Two sizes of these transmitters were used to accommodate the different sizes of the spring and summer migrants. Transmitters implanted in juvenile steelhead and yearling Chinook salmon were 7.3 mm in diameter x 18.0 mm in length and weighed 1.4 g in air (Lotek Wireless model 3KM) and those implanted in subyearling Chinook salmon were 6.3 mm x 4.5 mm x 14.5 mm long and weighed 0.85 g in air (Lotek Wireless model NTC-3-1). Transmitters were gastrically implanted using the methods of Martinelli et al. (1998).

Following tagging, fish were held in tanks at the juvenile bypass collection facility for 20 to 28 h to allow fish time to recover from the procedure. After the holding period, the tanks were checked for mortalities and fish were transported either to Rock Creek and released into the north channel of the Columbia River or were released through the spillway, juvenile bypass, or directly into the tailrace of JDA. Regurgitated tags were removed from the containers immediately prior to release when present.

Data Management and Analysis

Data from radio-telemetry receivers and the MITAS system were typically downloaded every other day and imported into SAS software for Personal Computers (SAS 1999) for subsequent proofing and analyses. The data were manually proofed to eliminate non-valid records including background noise, single records of a particular channel and code, records that were collected prior to the known release date and time, and records known to be fish eaten by avian or piscine predators. Generally, the minimum amount of data required to validate the presence of a radio-tagged fish was a combination of two master antenna and one auxiliary antenna detections or three master antenna detections within 1 to 2 min of each other.

The location and time an individual fish was first detected by telemetry receivers on the dam face was considered the route and time of entrance into the near-dam area. Similarly, the location and time of the last detection of an individual fish on the receivers on the dam face was considered the route and time of passage through the dam. However, radio-tagged fish were often detected on multiple auxiliary antennas where zones of coverage overlapped, making data reduction necessary. Fish detected on more than one auxiliary antenna within a two-minute period at the time of passage were assigned to a single passage location corresponding to the antenna where the highest strength signal was recorded and all other records were excluded. A two-minute interval was chosen because it approximately coincided with the upper boundary of time needed to complete a scan cycle if several fish were present at any given time. Manual tracking on the dams has verified that the last detection by telemetry receiving stations is typically a good estimate of the passage route (Sheer et al. 1997; Holmberg et al. 1998;

Hensleigh et al. 1999).

Fish passage efficiency was determined as the proportion of the total number of radio-tagged fish exiting the near-dam TDA forebay that passed via non-turbine routes (i.e., through the spillway or the ice-trash sluiceway) multiplied by 100%.

$$\text{FPE} = \frac{\text{fish last detected at spillway} + \text{fish last detected at sluiceway}}{\text{fish last detected at spillway} + \text{fish last detected at sluiceway} + \text{fish last detected at turbines}} \qquad \text{Equation 1}$$

Similarly, spill passage efficiency (SPE) and sluiceway passage efficiency (SLPE) were calculated as the proportion of the total number of radio-fish that passed through the spillway or sluiceway, respectively, multiplied by 100%.

$$\text{SPE} = \frac{\text{fish last detected at spillway}}{\text{fish last detected at spillway} + \text{fish last detected at sluiceway} + \text{fish last detected at turbines}} \qquad \text{Equation 2}$$

$$\text{SLPE} = \frac{\text{fish last detected at sluiceway}}{\text{fish last detected at spillway} + \text{fish last detected at sluiceway} + \text{fish last detected at turbines}} \qquad \text{Equation 3}$$

Statistical analyses comparing the passage indices calculated for each treatment, block, and day (0530 to 2059 hours) and night (2100 to 0529 hours) time periods were completed using logistic regression after adjusting for differences in blocks. Logistic regression is not based on assumptions of linearity, normality, or homoscedasticity. Logistic regression estimates the probability of an event (e.g., passing via a non-turbine route) after converting the dependent variable to a logit (the natural log of the event occurring or not). An "odds ratio" is calculated from the odds of the dependent variable occurring in each of the two classes (i.e., day and night passage), and from this, the relative importance of the independent variables in terms of the effects on the dependent variable is estimated (similar to a beta weight in a least-squares regression). For example, if the hypothetical odds ratio between day and night FPE is 5, the probability of passing via a non-turbine route during the day is 5 times greater than during the night. Overdispersion was assessed within each species by examining the models' residual deviance divided by residual degrees of freedom. Ninety-five percent profile likelihood confidence intervals were calculated for the overall odds ratio.

Residence time in the near-dam area, defined as the amount of time between the first and last detections in the forebay, was calculated for each radio-tagged fish detected in the near-dam forebay area (residence times were not calculated for fish detected only at entrance and exit stations). These residence times are minimum estimates of the actual time that radio-tagged fish spent in the near-dam area due to the chance that a fish might have been in the near-dam area for an unknown amount of time prior to their first detection and following their last detection.

Diel approach and passage patterns among blocks were compared graphically. Diel residence times within species were compared controlling for Block effects using Friedman's Chi-square test. Results of this test and others throughout this report were considered statistically significant when $P \leq 0.05$.

The detection efficiencies of the telemetry arrays at the powerhouse and spillway were calculated using a "double array" system as described by Lowther and Skalski (1997). This method is based on the number of fish detected and undetected at each of two arrays to determine the detection probability of each array, and ultimately, the combination of the two arrays. In a double-array system, the detection probability of one array is calculated as:

$$P1 = 11/(11+01) \qquad \text{Equation 4}$$

where 11 denotes fish that were detected on both arrays and 01 denotes those not detected on the first array, but detected on the second. The detection probability of the second array is calculated as:

$$P2 = 11/(11+10) \qquad \text{Equation 5}$$

where 10 denotes those detected on the first array, but not the second. The overall detection probability of the combined arrays is calculated as:

$$P12 = 1-((1-P1)(1-P2)) \qquad \text{Equation 6.}$$

The numbers of fish detected at each array are then adjusted by dividing the numbers detected at an array by the results of Equation 6 prior to calculation of the passage indices (e.g., FPE). Thus, the adjusted FPE would be calculated as:

$$FPE_{adj} = ((sp\# / P12_{spillway}) + (sl\# / P12_{sluiceway})) / ((ph\# / P12_{powerhouse}) + (sp\# / P12_{spillway}) + (sl\# / P12_{sluiceway})) \qquad \text{Equation 7}$$

where sp#, sl# and ph# are the numbers of fish detected passing the spillway, sluiceway and powerhouse, respectively. For the purpose of this exercise, the forebay aerial and underwater arrays at the powerhouse and spillway were each considered as a single upstream array (*P1*) for that route of passage and the aerial antennas in the tailrace of each area were considered the downstream arrays (*P2*). The two arrays in the sluiceway were composed of aerial antennas within the sluiceway between main unit 1 and the corner before the drop to the tailrace side (*P1*) and aerial antennas within the sluiceway at the roadway bridge near the sluiceway outfall (*P2*). Adjusted estimates of FPE, SPE and SLPE were used to determine if the unadjusted estimates used in statistical analyses were biased. The adjusted estimates were calculated for the general population of fish detected as well as the subset of fish detected at MU1-MU4. The detection probabilities of the general population of fish were used to adjust the estimates of the fish detected at the test units, as it was not possible to determine probabilities of these fish separately.

Spill effectiveness is calculated as a ratio of the percent of fish passed via the spillway (SPE) to the percentage of total river flow being spilled. This index was used to help identify potential relations between spill level, FPE or SPE estimates, and juvenile salmonid passage behavior.

Results from the Spring Study Period

Dam Operations

The mean hourly percent spill discharge at TDA during the spring was similar to the 40% spill proposed during the design phase of the study (Table 1, Appendix B). The mean hourly percent spill was 37.1% (range 20.9 to 72.4 %) during the day and 40.4% (range 22.8 to 75.0%) during the night during the spring study period, 02 May through 07 June 2002 (Figure 4). Mean hourly total discharge was 254 thousand cubic feet per second (KCFS) (range 142 to 422 KCFS) during the day and 247 KCFS (range 147 to 417 KCFS) at night. Figure 5 illustrates that while forebay elevation remained relatively stable throughout our study periods, there was an increase in temperature between the start and finish of both the spring and summer study periods.

Number of Fish Released and Detected

A total of 2724 juvenile steelhead and 3043 yearling Chinook salmon released at JDA were used for this study (Table 2). The study period occurred between the 27th and 90th percentiles of wild steelhead passage and the 12th and 96th percentiles of yearling Chinook salmon passage at JDA (Figure 6). The fish releases occurred at Rock Creek, through the JDA spillway and juvenile bypass system outfall, and in the JDA tailrace from 02 May through 07 June. Juvenile steelhead from all releases combined had a mean fork length of 188 mm (range 102 to 275 mm) and a mean weight of 61 g (range 21 to 203 g). Yearling Chinook salmon from all releases combined had a mean fork length of 148 mm (range 116 to 215 mm) and a mean weight of 33 g (range 16 to 107 g). The mean fork length of all fish sampled at the JDA smolt

Table 1. Mean hourly percentages of total discharge spilled and total hourly discharge (thousand cubic feet per second) at The Dalles Dam when upper portions of turbine intakes were occluded or unoccluded, 02 May through 07 June 2002. Blocks consisted of one 3-day treatment with turbine intakes on turbine units one through four partially occluded and a second 3-Day treatment without the intakes occluded. Day and night refers to the spill periods from 0530-2059 hours and 2100-0529 hours, respectively. Std=standard deviation.

		Percent hourly spill					
		Day			Night		
Block	**Treatment**	Mean	Std	Range	Mean	Std	Range
3	Occluded	39.2	1.8	32.3-42.0	39.8	0.9	37.1-41.8
3	Unoccluded	38.7	1.8	34.3-40.4	38.7	1.7	34.4-42.1
4	Occluded	37.7	1.7	34.2-41.1	39.2	0.9	37.4-40.5
4	Unoccluded	39.2	0.8	37.6-40.5	39.2	1.0	36.8-41.9
5	Occluded	39.0	1.1	37.0-40.6	38.9	1.4	36.6-41.6
5	Unoccluded	37.9	1.5	34.0-41.5	38.7	1.2	36.2-41.0
6	Occluded	39.5	0.8	37.9-41.5	39.5	1.0	36.6-41.2
6	Unoccluded	35.0	3.8	27.8-40.0	35.1	3.2	29.2-40.0
7	Occluded	24.4	1.8	20.9-27.4	27.8	3.8	22.8-37.3
7	Unoccluded	34.8	4.1	25.7-41.8	34.3	4.3	26.7-40.4
8	Occluded	42.0	10.1	31.5-72.4	62.8	10.1	38.2-75.0
8	Unoccluded	37.7	14.4	22.3-70.5	50.5	16.7	22.8-71.7

		Total hourly discharge					
		Day			Night		
Block	**Treatment**	Mean	Std	Range	Mean	Std	Range
3	Occluded	225.1	43.7	149.6-340.5	220.6	32.3	172.9-296.1
3	Unoccluded	218.3	36.0	148.5-280.9	241.3	23.5	187.7-279.7
4	Occluded	208.5	31.4	170.2-306.1	207.6	23.9	177.2-262.7
4	Unoccluded	197.2	40.0	142.2-267.9	184.6	35.9	147.2-262.1
5	Occluded	208.5	23.8	168.4-247.8	195.6	28.1	153.9-238.3
5	Unoccluded	207.5	24.6	167.2-265.2	215.8	24.5	186.0-262.0
6	Occluded	260.8	17.8	229.6-298.9	254.7	20.7	217.4-300.9
6	Unoccluded	257.2	22.9	215.5-308.1	258.0	24.0	212.4-308.9
7	Occluded	310.9	21.9	275.8-358.0	274.9	35.4	201.1-329.6
7	Unoccluded	254.9	33.3	208.8-330.9	253.1	40.4	207.5-318.9
8	Occluded	368.1	34.3	307.5-422.9	353.3	23.7	319.8-417.1
8	Unoccluded	331.7	38.2	179.1-407.6	306.6	34.6	259.6-392.9

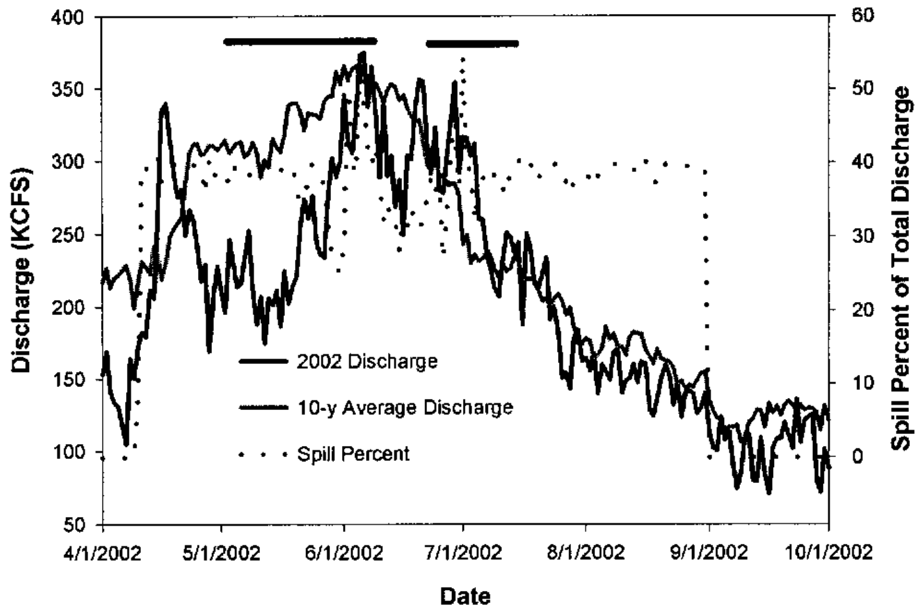

Figure 4. Total project discharge in thousand cubic feet per second (KCFS), 10-year average discharge and percent spill at The Dalles Dam between 01 April and 01 October 2002. Horizontal bars indicate spring (02 May to 07 June) and summer (25 June to 13 July) study periods. Data from University of Washington at http://www.cqs.washington.edu/dart/river.html.

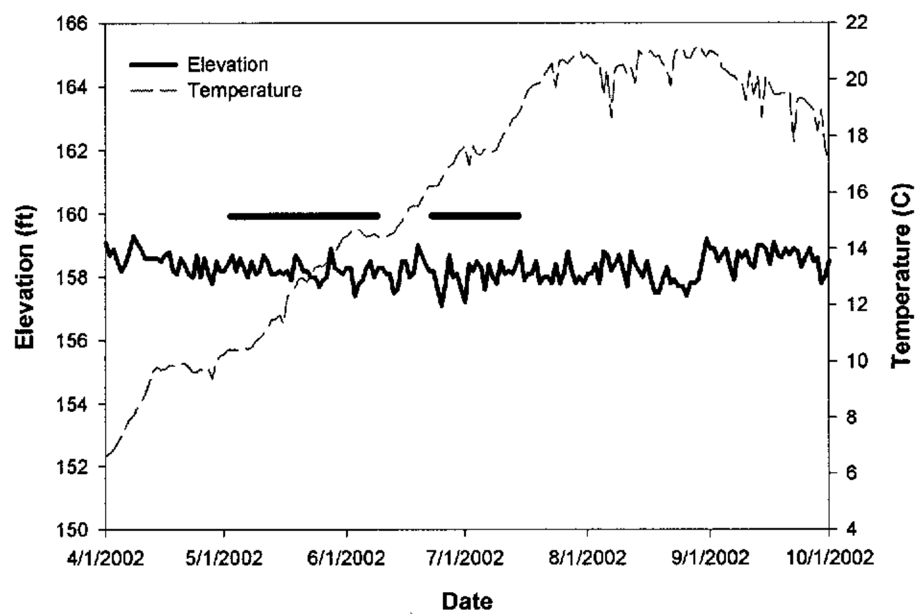

Figure 5. Elevation and water temperature at The Dalles Dam forebay between 01 April and 01 October, 2002. Horizontal bars indicate periods of spring (02 May to 07 June) and summer (25 June to 13 July) releases of radio-tagged fish. Data from University of Washington at http://www.cqs.washington.edu/dart/river.html.

Table 2. Numbers of radio-tagged juvenile wild steelhead and hatchery yearling Chinook salmon released at Rock Creek (JDR) above John Day Dam (JDA), in the JDA bypass facility (JBS), through JDA spillbays (JSB), and in the JDA tailrace (JDT), and the percentages of fish detected by the radio-telemetry receivers at The Dalles Dam, spring 2002.

	Juvenile wild steelhead		Yearling Chinook		Total	
Release site	Number released	Percent detected	Number released	Percent detected	Number released	Percent detected
JDR	602	77.4	1569	78.6	2171	78.3
JBS	528	79.4	583	72.7	1148	75.8
JSB	709	83.8	-	-	709	83.8
JDT	885	90.7	891	88.4	1776	89.6
Overall	2724	83.8	3043	80.3	5767	81.9

monitoring facility during the study period was 199 mm (range 125 to 390 mm) for juvenile steelhead and 146 mm (range 97 to 245 mm) for yearling Chinook salmon (R. Martinson, Pacific States Marine Fisheries Commission, personal communication). Detailed summaries of all releases are presented in Appendices C through I. The mean tag-weight-to-body-weight ratios of juvenile steelhead and yearling Chinook salmon were 2.3 % (range 1.0 to 6.4%) and 4.2% (range 1.3 to 8.7%). Telemetry equipment at the dam detected 84% of the juvenile steelhead released and 80% of the yearling Chinook salmon released.

Arrival Time, Travel Time, and Approach Pattern

The hour of arrival at TDA of both species was dispersed throughout the diel period though the arrival of juvenile steelhead peaked near noon (Figure 7). Juvenile steelhead and yearling Chinook salmon median travel times from the Rock Creek release site to the TDA near-dam forebay were 61.8 and 46.2 h, respectively. The median travel times of juvenile steelhead and yearling Chinook salmon released at the JDA tailrace were 16.2 h and 19.6 h.

Locations of first detections of juvenile steelhead were similar between treatments but did show diel differences. Of the juvenile steelhead arriving during the daytime occluded treatments, 33% were first detected at the powerhouse and 67% were first detected at the spillway; during the unoccluded treatment 39% were first detected at the powerhouse and 61% were first detected at the spillway. The distribution of arrival location was more equitable at night as 46% were first detected at the powerhouse and 54% at the spillway during the occluded treatment and 47% were first detected at the powerhouse and 53% at the spillway during the unoccluded treatment.

First detections of yearling Chinook salmon during the daytime occluded treatment were 53% at the powerhouse and 47% at the spillway, and during the unoccluded treatment they were 51% and 49%, respectively. At night, 33% were first detected at the powerhouse and 67% at the spillway during the occluded treatment and 42% were first detected at the powerhouse and 58% at the spillway during the unoccluded treatment. Although more fish were first detected at the

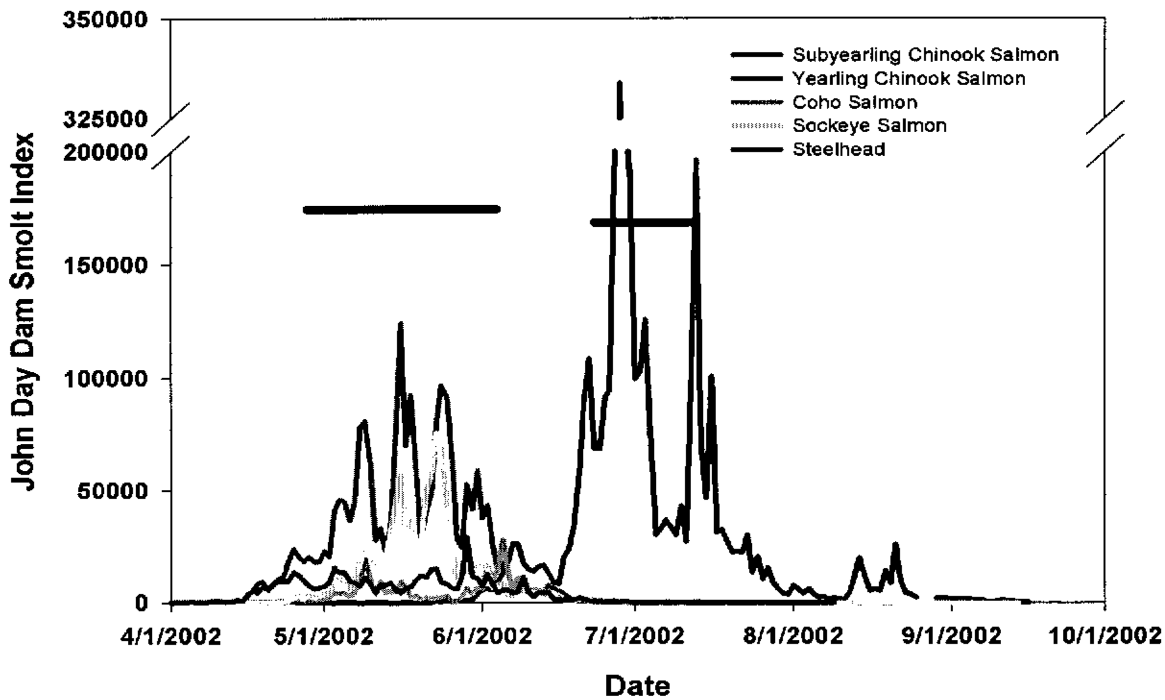

Figure 6. Smolt Passage Index at John Day Dam between 01 April and 01 October 2002. Horizontal bars indicate periods of spring (29 April to 06 June) and summer (21 June to 12 July) releases of radio-tagged fish. Data from University of Washington data access in real time website at http://www.cqs.washington.edu/dart/pass rpt.html

spillway than the powerhouse during both treatments, the number of first detections at the spillway was proportionately greater during the occluded treatment.

The differences in approach pattern based on treatment were species dependent. The first detections of steelhead were on deeper underwater antennas during the night than during the day but there was little difference between treatments (Figure 8). The area of first detection of yearling Chinook salmon was also similar during occluded and unoccluded treatments but showed a trend opposite to that of steelhead by having more first detections occur on deeper antennas during the day than at night (Figure 9).

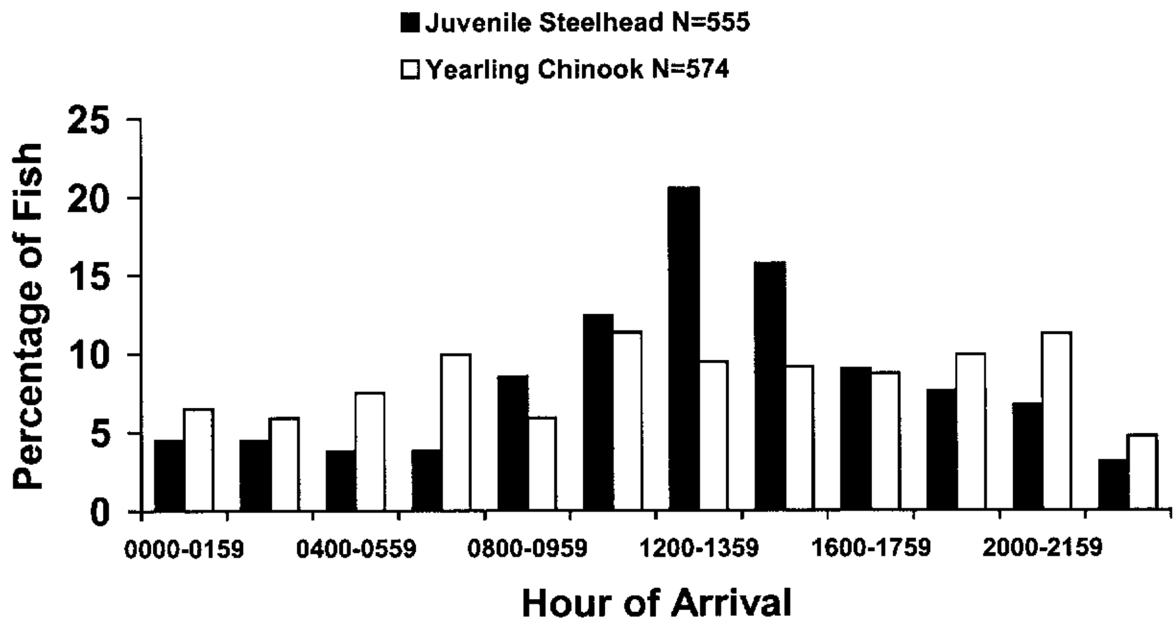

Figure 7. Diel distribution of radio-tagged juvenile steelhead and yearling Chinook salmon hour of arrival among 2-h intervals at John Day Dam, 02 May through 07 June 2002. N = sample size. Figure is based only on fish detected on MU1-MU3.

The area a fish was first detected was usually the area it passed the dam (Figures 10 and 11). However, there were treatment differences among steelhead first detection areas and subsequent passage locations. For example, of the juvenile steelhead that passed the dam through MU1-MU3, 83% had a first detection at MU1-MU3 during the unoccluded treatment, and during the occluded treatment only 48% of the steelhead passing the dam in that area were first detected there. Yearling Chinook salmon, however, showed very little difference between the unoccluded and occluded treatments with regard to detection and subsequent passage at MU1-MU3 (69 and 76%, respectively).

The passage locations of fish detected near the test units were examined to determine the effects of the SGIDs. Juvenile steelhead first detected at the piernoses between MU1-MU3 were most likely to pass via the sluiceway regardless of the treatment (Figure 12). The SGIDs increased spill passage of steelhead by 11% but had little effect on turbine passage that was low under both treatments. Yearling Chinook salmon showed some passage differences with regard to treatment. During the occluded treatment, there was a reduction in turbine passage and an increase in sluiceway and spillway passage (Figure 13).

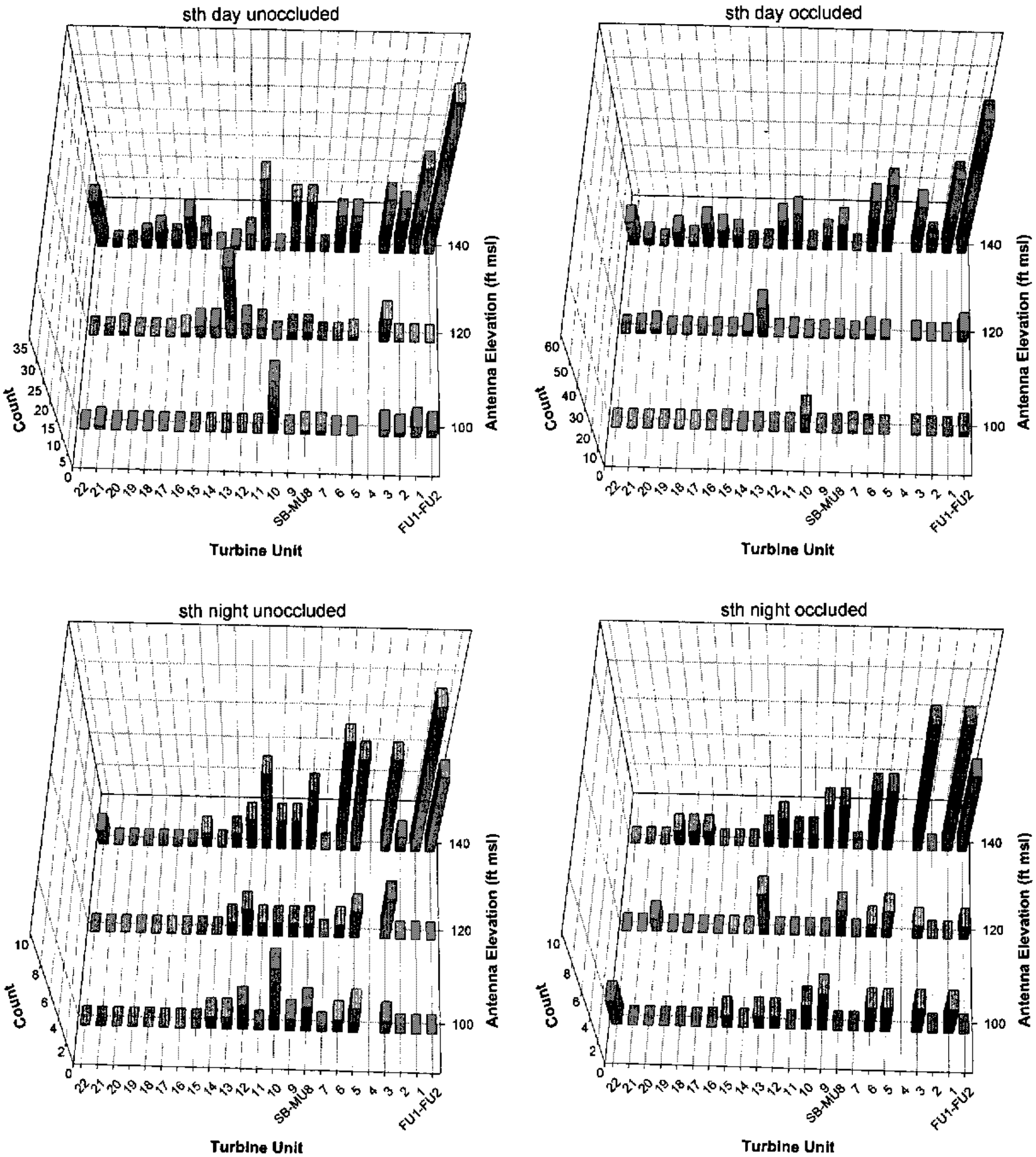

Figure 8. Numbers of radio-tagged juvenile wild steelhead first detected at underwater antennas at the powerhouse of The Dalles Dam during day and night time periods within occluded and unoccluded treatments during spring 2002. Underwater antennas were located on piernoses between main turbine units at elevations 140, 120 and 100 ft msl. Turbine unit designations include combined areas at the two fish units (FU1-FU2) and between the piernose between main unit 9 and the service bay (between main units 8 and 9) and the service bay to the downstream piernose of main unit 8 (SB-MU8). All other turbine units indicated represent detections at the antennas affixed to the piernose immediately upstream of the unit. Data from unit 4 was omitted due to a malfunction.

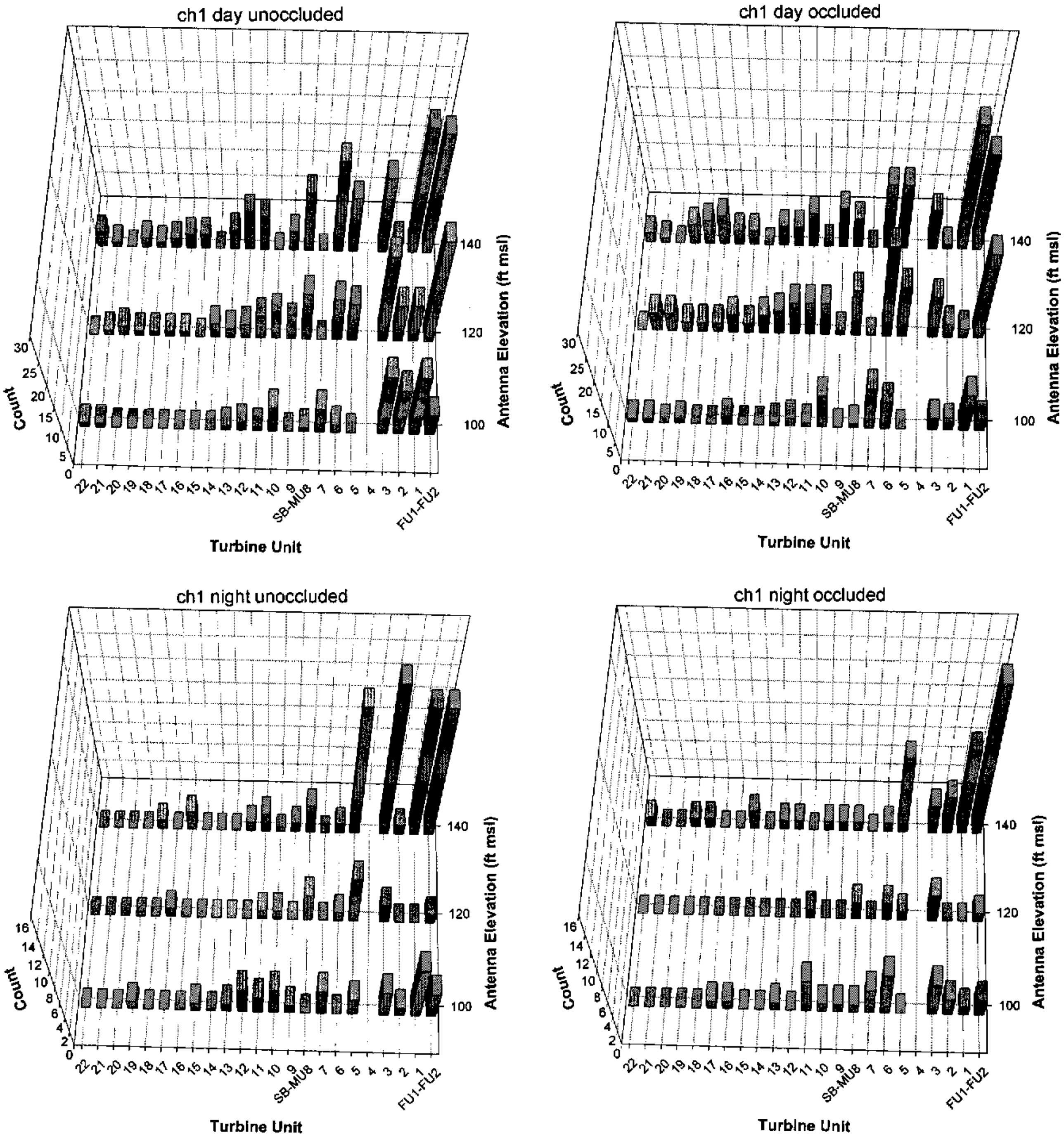

Figure 9. Numbers of radio-tagged yearling Chinook salmon first detected at underwater antennas at the powerhouse of The Dalles Dam during day and night time periods within occluded and unoccluded treatments during spring 2002. Underwater antennas were located on piernoses between main turbine units at elevations 140, 120 and 100 ft msl. Turbine unit designations include combined areas at the two fish units (FU1-FU2) and between the piernose between main unit 9 and the service bay (between main units 8 and 9) and the service bay to the downstream piernose of main unit 8 (SB-MU8). All other turbine units indicated represent detections at the antennas affixed to the piernose immediately upstream of the unit. Data from unit 4 was omitted due to a malfunction.

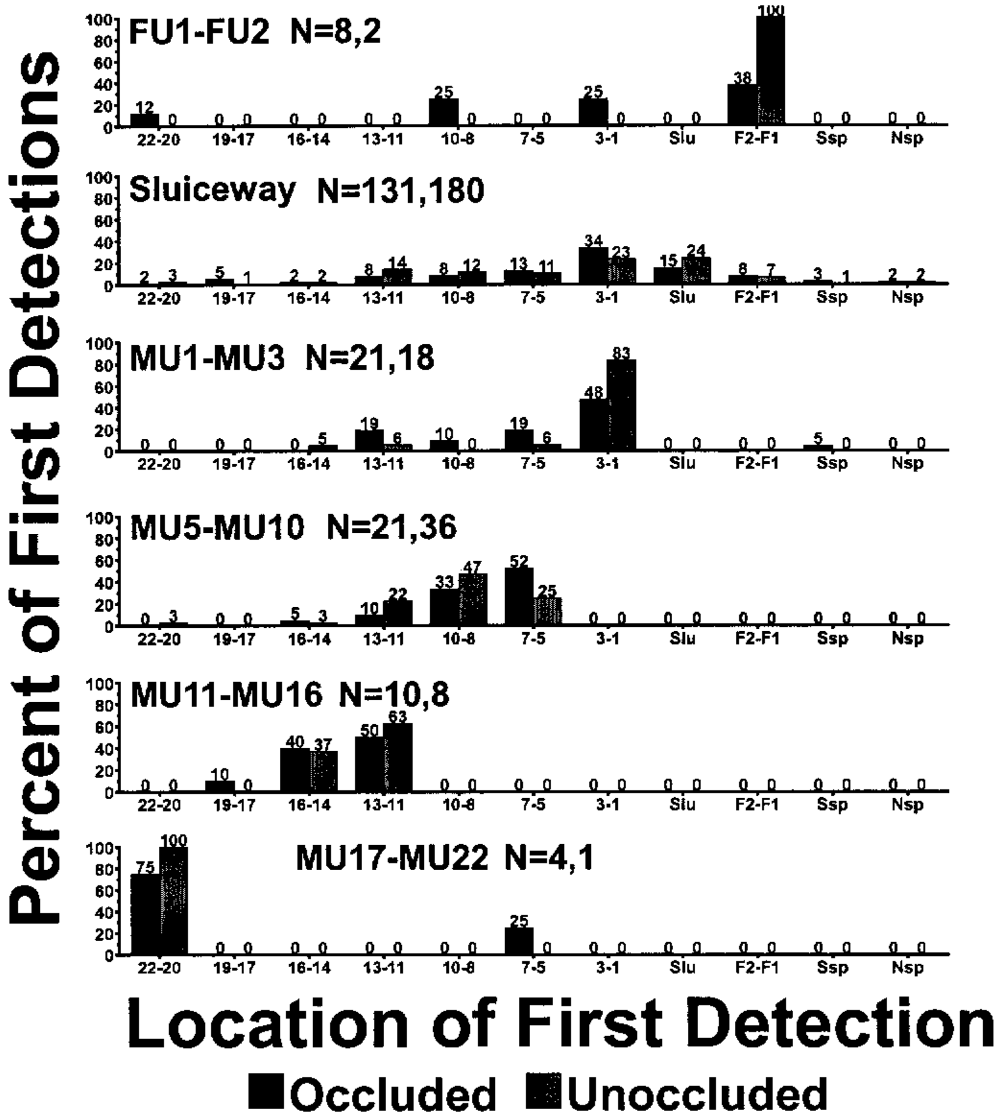

Figure 10. Percentage of radio-tagged wild juvenile steelhead passing The Dalles Dam at the sluiceway, fish turbine unit 1and 2 (FU1, FU2), main turbine units 1 through 3 (MU1-MU3), main turbine units 5 through 10 (MU5-MU10), main turbine units 11 through 15 (MU11-MU15), and main turbine units 16 through 22 (MU16-MU22) during occluded and unoccluded turbine intake treatments, spring 2002, that were first detected within 10 m of the dam at main turbine units 1-22, fish turbine units (F2-F1), sluiceway (Slu), and north and south spillway (Nsp, Ssp). No data were obtained at main turbine unit 4 due to antenna failure. Numbers above bars are the percentage of fish first detected at each location. Sluiceway antennas detected only fish within the sluiceway.

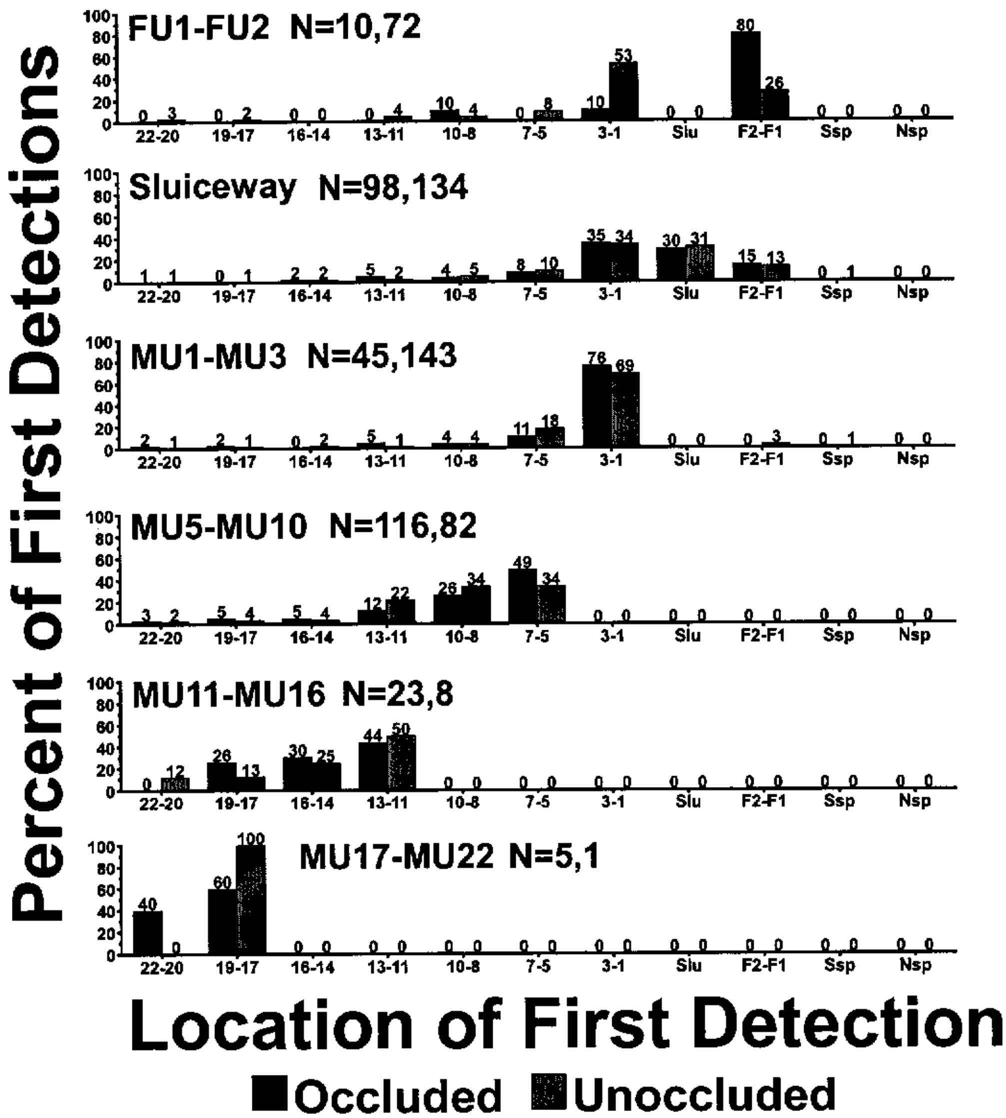

Figure 11. Percentage of radio-tagged yearling Chinook salmon passing The Dalles Dam at the sluiceway, fish turbine unit 1and 2 (FU1, FU2), main turbine units 1 through 3 (MU1-MU3), main turbine units 5 through 10 (MU5-MU10), main turbine units 11 through 15 (MU11-MU15), and main turbine units 16 through 22 (MU16-MU22) during occluded and unoccluded turbine intake treatments, spring 2002, that were first detected within 10 m of the dam at main turbine units 1-22, fish turbine units (F2-F1), sluiceway (Slu), and north and south spillway (Nsp, Ssp). No data were obtained at main turbine unit 4 due to antenna failure. Numbers above bars are the percentage of fish first detected at each location. Sluiceway antennas detected only fish within the sluiceway.

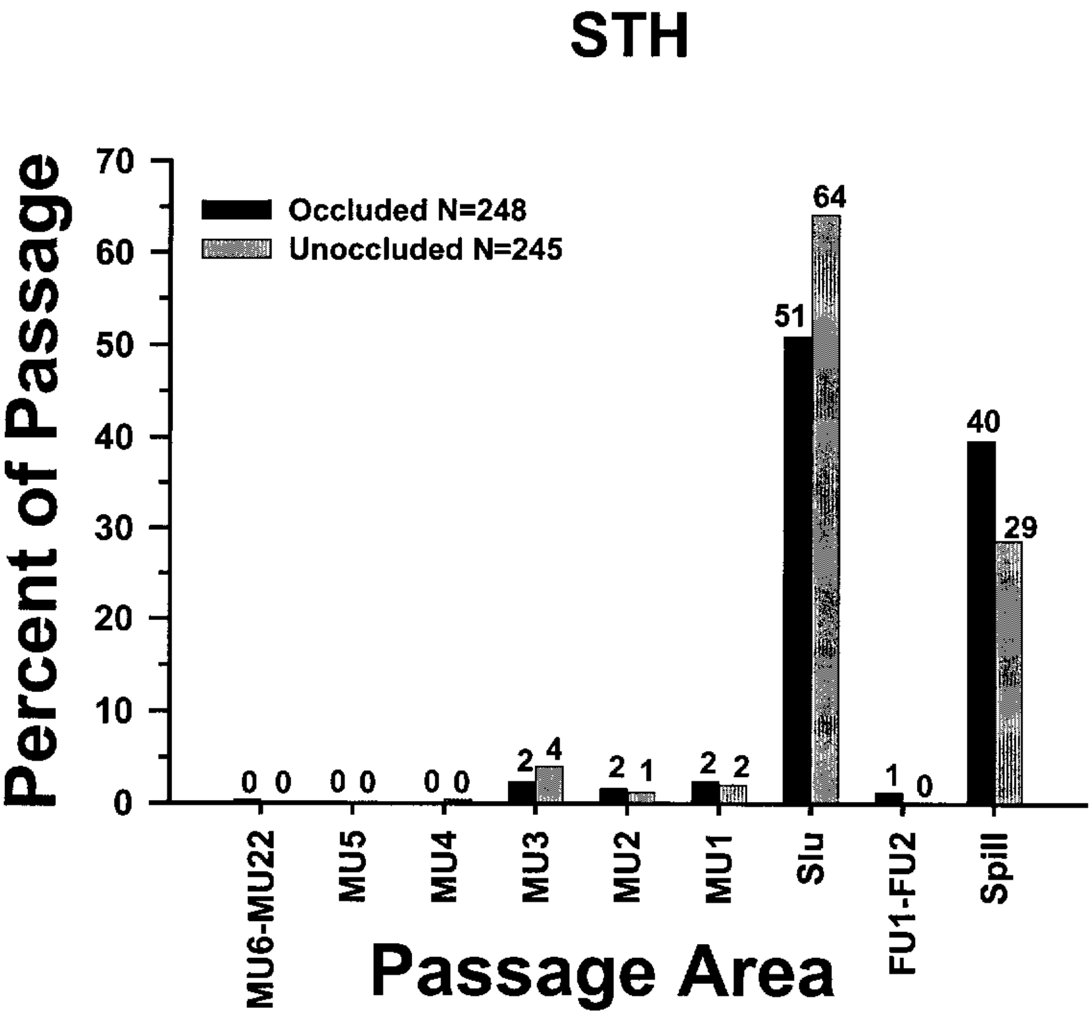

Figure 12. Passage locations of radio-tagged wild juvenile steelhead detected on underwater antennas at the piernose between main unit 3 (MU3) and main unit 4 (MU4) during occluded and unoccluded treatments. Slu=sluiceway, FU1-FU2=fish units 1 and 2, Spill=spillway. The number above each bar indicates the percentage the bar represents.

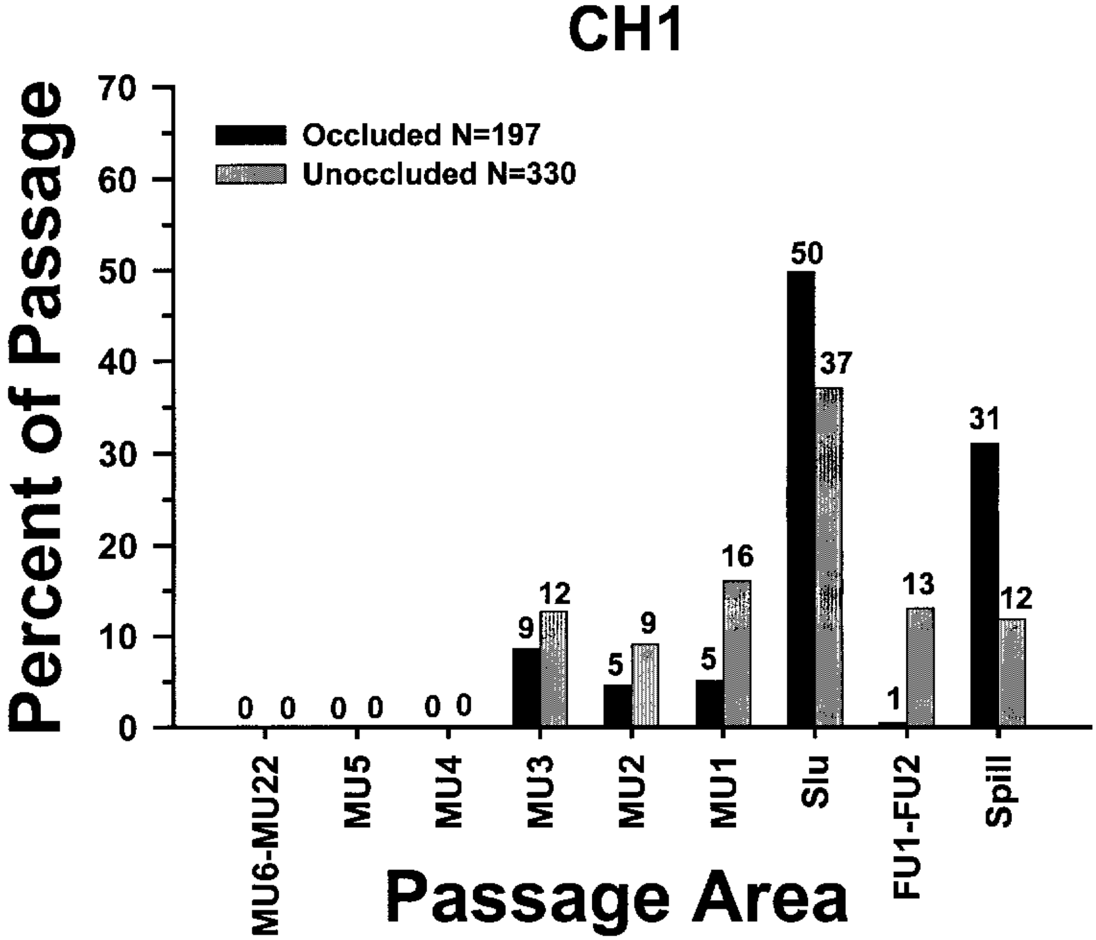

Figure 13. Passage locations of radio-tagged yearling Chinook salmon detected on underwater antennas at the piernose between main unit 3 (MU3) and main unit 4 (MU4) during occluded and unoccluded treatments. Slu=sluiceway, FU1-FU2=fish units 1 and 2, Spill=spillway. The number above each bar indicates the percentage the bar represents.

Forebay Residence Times

The median forebay residence times of fish detected ranged from 0.2 to 0.5 h for juvenile steelhead and from 0.1 to 0.2 h for yearling Chinook salmon. Juvenile steelhead detected at MU1-MU3 had residence times ranging from 0.2 h to 0.9 h for the occluded treatment and from 0.2 h to 0.8 h for the unoccluded treatment during the day and from 0.2 h to 14.0 h for the occluded and from 0.01 to 2.0 h during the unoccluded treatments at night (Figure 14). The large range of residence times for some blocks in Figure 14 can be attributed to the small sample sizes of those blocks. There were no significant diel differences in residence times of yearling Chinook salmon, but differences between treatments were highly significant ($P < 0.0001$) with extended residence during the occluded treatment. Yearling Chinook salmon had residence times of 0.4 h for the occluded treatment and 0.2 h for the unoccluded treatment during the day and 0.3 h and 0.2 h for the occluded and unoccluded treatments, respectively, at night.

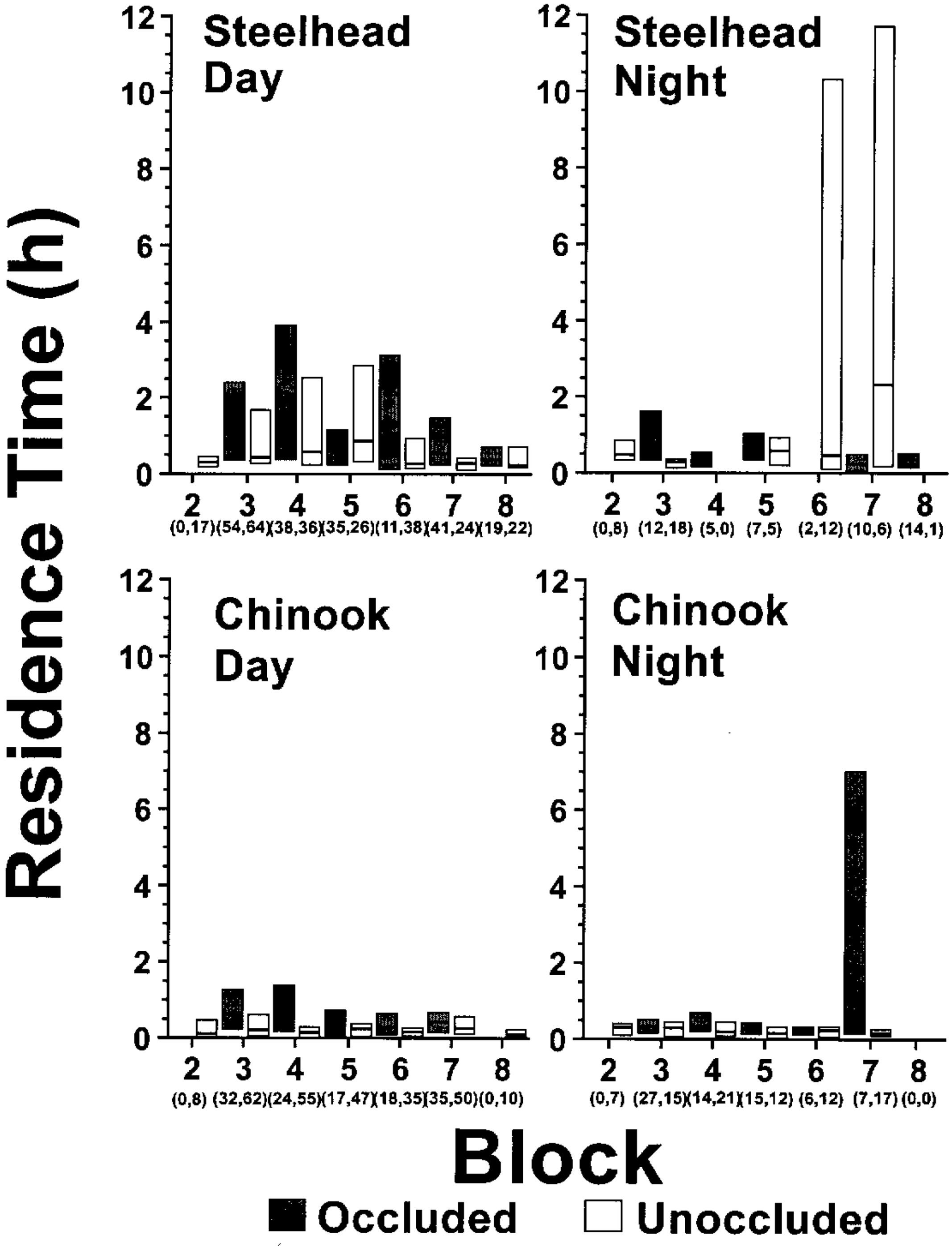

Figure 14. Twenty-fifth, 50th (median), and 75th percentiles (lower, middle, and upper horizontal lines on bars) of radio-tagged wild juvenile steelhead and hatchery yearling Chinook salmon forebay residence times (h) by diel time of arrival during occluded and unoccluded treatments at The Dalles Dam, spring 2002. Bars for sample sizes < 3 not shown.

General Route and Time of Passage

Diel differences among the areas of passage for all radio-tagged fish were evident for juvenile steelhead, with proportionately more fish passing via the powerhouse and fewer via the spillway at night but little diel difference in passage area of yearling Chinook salmon was present. Overall, 80% of the juvenile steelhead passing the dam during the day (day passage N =1706) were last detected at the spillway, 6% were last detected at the powerhouse and 14% were last detected in the sluiceway. At night, the proportions were 62, 23, and 15% at the spillway, powerhouse and sluiceway, respectively, indicating decreases in spillway passage and an increase in powerhouse passage at night (night passage N =413). The proportions of yearling Chinook salmon passing via the spillway, powerhouse and sluiceway were 61, 31, and 8% during the day (day passage N = 1561) and 61, 25, and 14% at night (night passage N = 674).

Of fish detected at MU1-MU3, the sluiceway was the most common route of passage of each species (Figures 12 and 13). Sluiceway passage of juvenile steelhead during the occluded and unoccluded treatments was 51 and 64%. Yearling Chinook salmon passage had a trend opposite to steelhead passage as more fish passed via the sluiceway during the occluded treatment (50%) than during the unoccluded (37%). Spillway passage of juvenile steelhead during the occluded and unoccluded treatments was 40 and 29% and powerhouse passage was 9 and 7%. Spillway passage of yearling Chinook salmon during the occluded and unoccluded treatments was 31 and 12% and powerhouse passage was 19 and 51%. Figure 15 shows that there was some diel effect on passage of yearling Chinook salmon. Although the sluiceway was the predominant passage route when diel periods were combined, day passage was more frequently through the spillway during the occluded treatment and through the turbines during the unoccluded treatment.

The time of day that radio-tagged fish detected at MU1-MU3 passed TDA was dispersed throughout the diel period, though passage of juvenile steelhead was greatest between 1200 and 2159 hours (Figure 16). The greatest passage of yearling Chinook salmon was between 2000 and 2159 hours, but passage was relatively constant throughout the diel period. Overall, the occluded and unoccluded treatments had little effect on the hour of passage of either species. Appendix J contains passage data by block, treatment, diel period, and date.

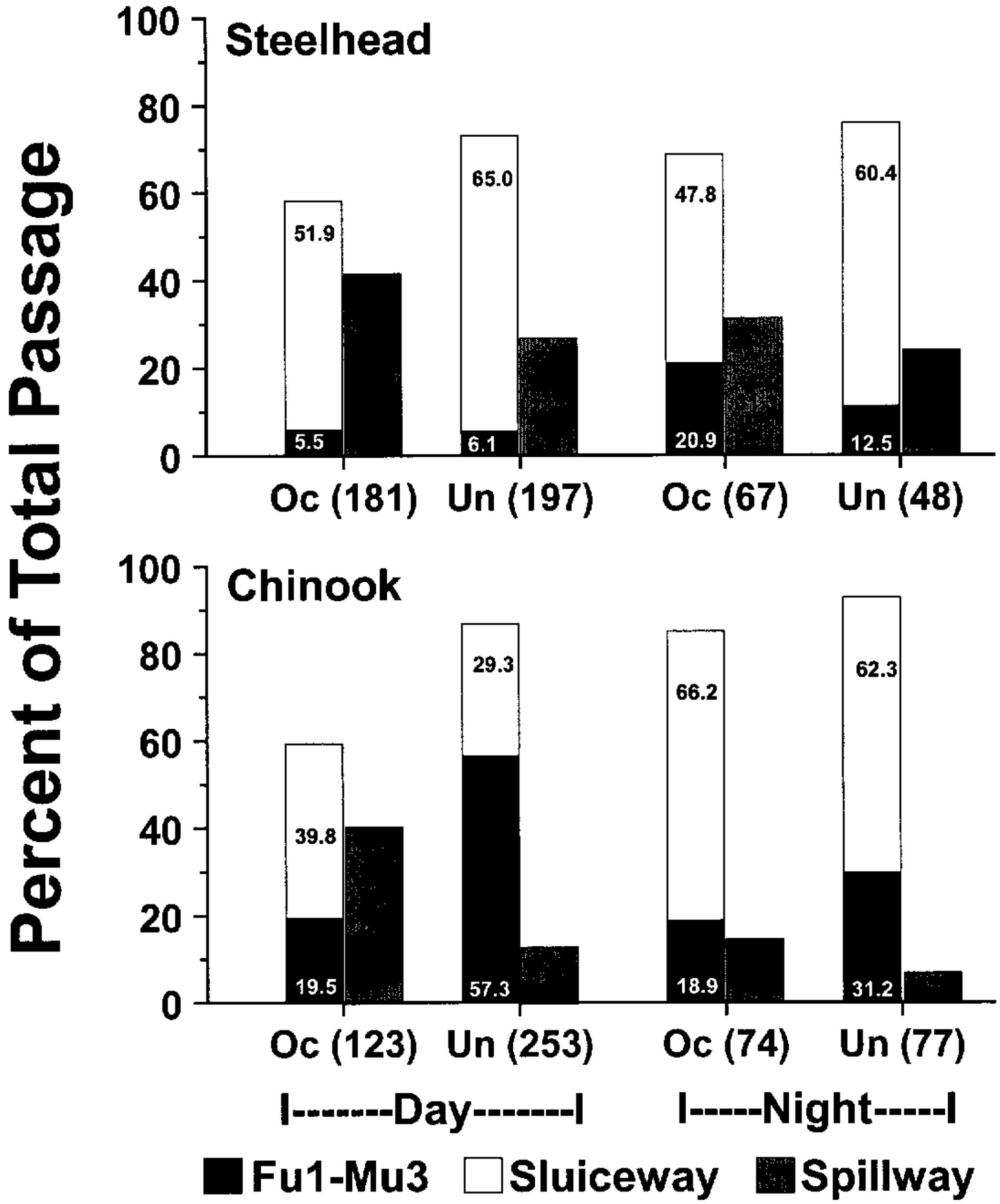

Figure 15. Percentage of radio-tagged juvenile steelhead and yearling Chinook salmon detected at main turbine units 1 through 3 that were detected passing through the turbines, sluiceway, or spillway at The Dalles Dam during occluded (Oc) and unoccluded (Un) turbine intake treatments, spring 2002. Passage percentages for each area and treatment are shown on bars. Day and Night refer to periods between 0531-2059 hours and 2100-0530 hours. Sample sizes are shown in parentheses.

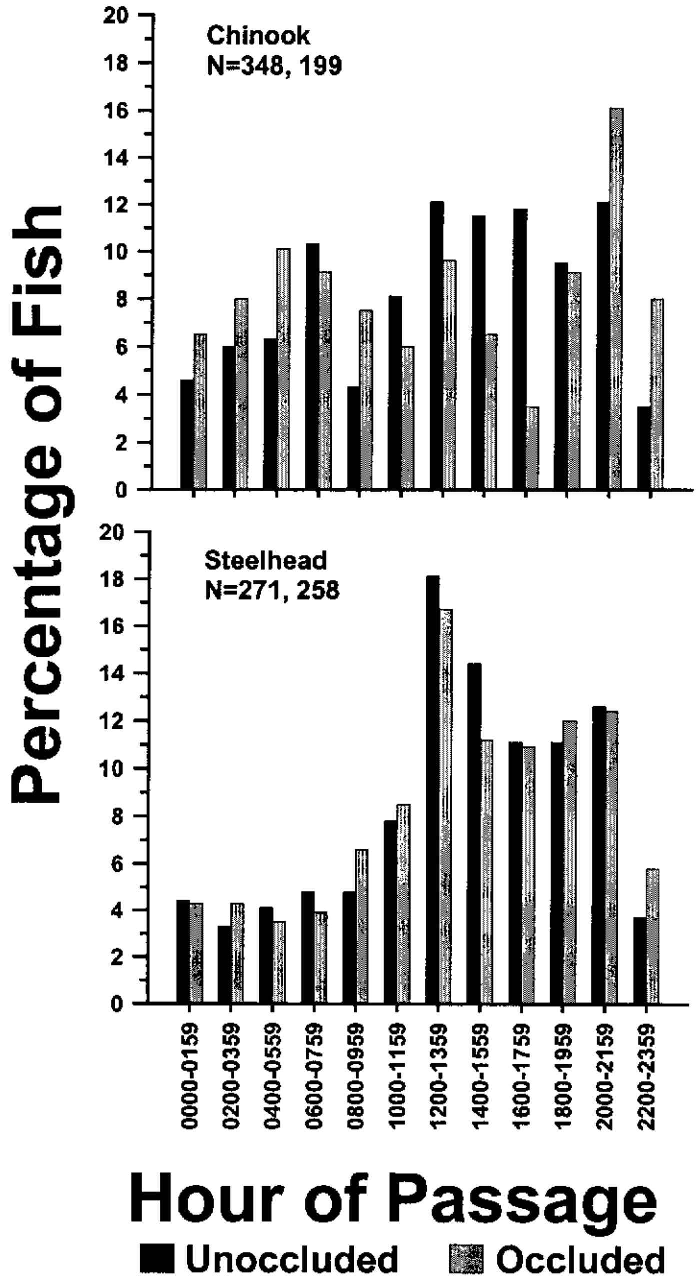

Figure 16. Diel distribution of radio-tagged steelhead and yearling Chinook salmon passage at The Dalles Dam during unoccluded and occluded treatments, 02 May through 07 June 2002. N = unoccluded treatment sample size, occluded treatment sample size. Includes only those fish detected at MU1-MU3.

Fish, Spill, and Sluiceway Passage Efficiencies

Non-turbine passage of the general population of radio-tagged fish passing the dam (pooling treatments) was greater for juvenile steelhead than yearling Chinook salmon. Overall FPE, SPE, and SLPE estimates of juvenile steelhead were 90, 76, and 14% and those of yearling Chinook salmon were 70, 60, and 10%. For all comparisons of treatments, only fish detected at the units testing the SGIDs (MU1-MU3) were used in the analyses (Appendices K-P).

There were no significant differences between the FPE point estimates of juvenile steelhead in each treatment during the day (94.5 and 93.9%) or night (79.1 and 87.5%) and this was evident when treatment blocks were analyzed separately and when the blocks were pooled (Figure 17, Table 3). Significant differences in SLPE and SPE were present between treatments during the day, but they did not result in a net change in FPE. The SLPE during the occluded treatment in the day was 13 % lower than during the unoccluded treatment and SPE was greater by the same amount (Chi-Square, $P = 0.02$ and 0.03, df=1). The FPE during each treatment was greater during the day than the night.

The FPE and SPE of yearling Chinook salmon during the day were significantly greater during the occluded treatment, but no significant differences were present at night (Table 4, Figure 18, Appendices N, O, and P). The passage trend is evident in both individually analyzed blocks and pooled blocks (Figure 18, Table 4). The greater FPE of the occluded treatment in the day was accompanied by a 10.5% increase in SLPE and a 27.3% increase SPE. The difference in SPE was statistically significant (Chi-Square, $P < 0.0002$, df=1; Appendix O), but the difference in SLPE was not statistically significant at the $\alpha = 0.05$ level (Chi-Square, $P = 0.06$, df=1;

Appendix P). Differences in these indices at night were not statistically significant. The FPE during the occluded treatment was similar during day and night periods (80.5% day and 81.1% night), but the FPE during the unoccluded treatment was 26.1% lower during the day (42.7%) than the night (68.8%).

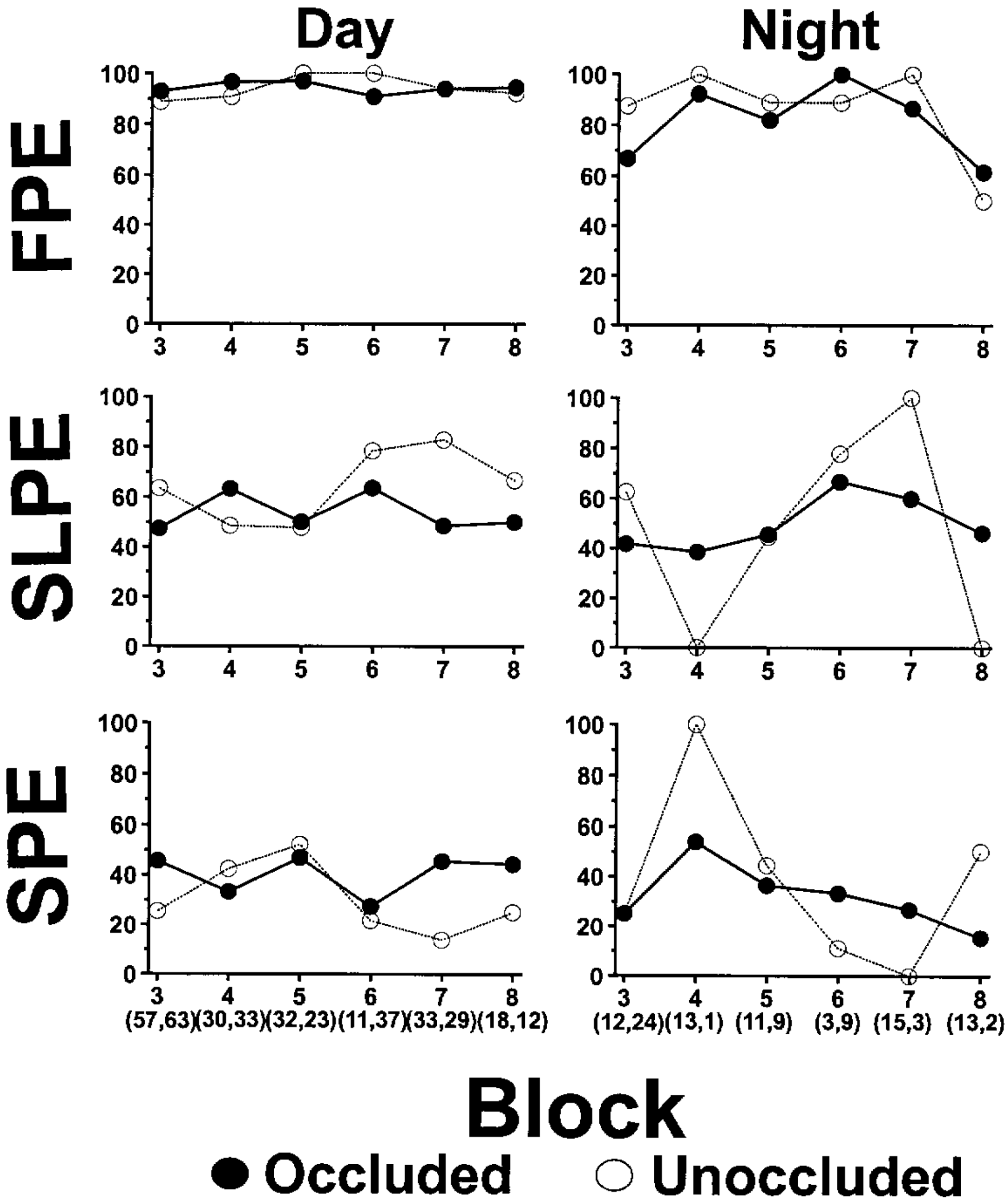

Figure 17. Fish passage efficiency (FPE), sluiceway passage efficiency (SLPE), and spill passage efficiency (SPE) of wild juvenile steelhead detected within 10 m of main turbine unit 1 through 3 during six study blocks between 02 May and 31 May 2002. Sample sizes for each treatment and block are in parentheses (occluded, unoccluded). All data are in percents.

Table 3. Diel passage estimates (Est) of juvenile steelhead detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded turbine intake treatments at The Dalles Dam, 02 May through 07 June 2002. Diel period: Day = 0530-2059 hours, Night = 2100-0529 hours. FPE = fish passage efficiency. SPE = spill passage efficiency. SLPE = sluiceway passage efficiency. N=sample size. LRCI = likelihood ratio confidence interval.

Diel period	Passage metric	Occluded			Unoccluded		
		Est	95%LRCI	N	Est	95%LRCI	N
Day	FPE	94.5	90.5-97.2	189	93.9	90.0-96.7	215
	SPE	42.5	35.5-49.8	189	28.9	22.9-35.5	215
	SLPE	51.9	44.7-59.2	189	64.5	57.8-70.9	215
Night	FPE	79.1	68.4-87.6	67	87.5	76.3-94.8	54
	SPE	31.3	21.1-43.0	67	27.1	15.9-40.6	54
	SLPE	47.8	44.7-59.2	67	60.4	58.1-71.4	54

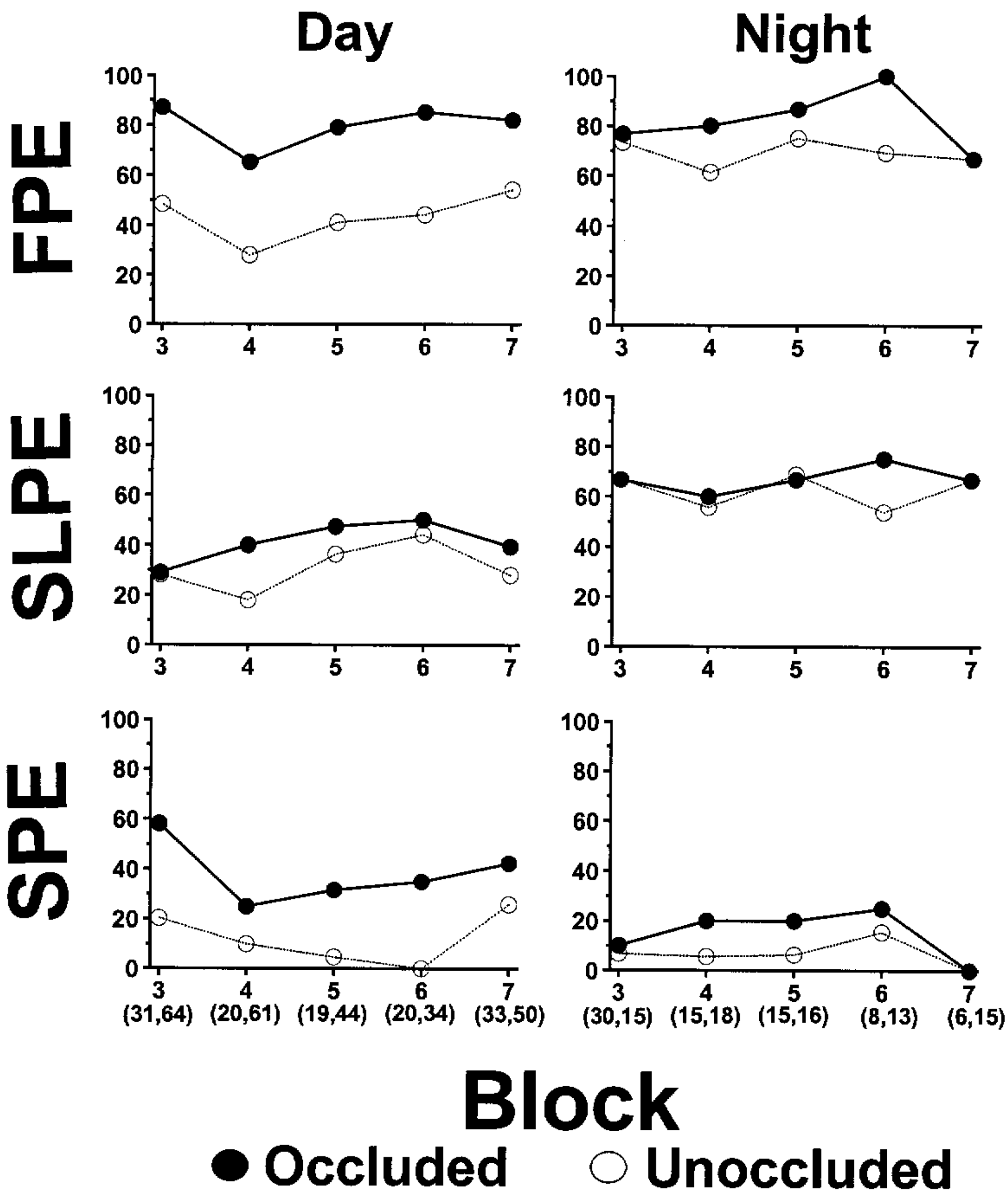

Figure 18. Fish passage efficiency (FPE), sluiceway passage efficiency (SLPE), and spill passage efficiency (SPE) of yearling Chinook salmon detected within 10 m of main turbine units 1 through 3 during five study blocks 02 May through 25 May 2002. Sample sizes for each block and treatment are shown in parentheses (occluded, unoccluded). All data are in percents.

Table 4. Diel passage estimates (Est) of yearling Chinook salmon detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded turbine intake treatments at The Dalles Dam, 02 May through 07 June 2002. Diel period: Day = 0530-2059 hours, Night = 2100-0529 hours. FPE = fish passage efficiency. SPE = spill passage efficiency. SLPE = sluiceway passage efficiency. N=sample size. LRCI = likelihood ratio confidence interval.

Diel period	Passage efficiency	Occluded			Unoccluded		
		Est	95%LRCI	N	Est	95%LRCI	N
Day	FPE	80.5	70.5-88.4	123	42.7	35.0-50.6	267
	SPE	40.7	25.2-57.5	123	13.4	6.8-22.7	267
	SLPE	39.8	31.5-48.6	123	29.3	23.9-35.0	267
Night	FPE	81.1	71.2-88.9	74	68.8	58.0-78.4	84
	SPE	14.9	8.4-23.4	74	6.5	2.6-12.9	84
	SLPE	66.2	55.0-76.3	74	62.3	51.2-72.6	84

Spill Effectiveness

The spill effectiveness for juvenile steelhead and yearling Chinook salmon detected at The Dalles Dam was 1.9:1 and 1.5:1, respectively. The ratios are based on total fish detected and are therefore unrelated to treatment comparisons.

Detection efficiencies

The detection efficiencies of the arrays at the powerhouse, spillway, and sluiceway ranged from 91% to 100% with the lowest detection efficiencies for both species occurring at the sluiceway (Table 5). The efficiencies of the forebay arrays were greater than the tailrace arrays, as indicated by the small incidence of "01" capture histories relative the "10" histories in most cases. Most fish were detected on both arrays, as indicated by the large "11" capture histories relative to the "01" and "10" histories. There was little difference in overall detection efficiencies (i.e., P12) between diel periods, species, or treatments.

The adjusted passage estimates were calculated for the general population of fish detected as well as the subset of fish detected at MU1-MU3. The detection probabilities of the general population of fish were used to adjust the estimates of the fish detected at the test units, as it was not possible to determine probabilities of these fish separately. The differences in detection probabilities between the spillway, powerhouse and sluiceway arrays resulted in a maximum of one percent difference in the passage index estimates of the general population of fish and a two percent difference for fish detected at MU1-MU3 (Tables 6 and 7).

Table 5. Diel capture histories and detection probabilities of telemetry detection arrays at the powerhouse, sluiceway and spillway at The Dalles Dam, spring 2002. Data in this table were used to adjust passage estimates (pooling treatments). See text for capture history and detection probability definitions.

Capture History	**Steelhead**											
	Occluded						Unoccluded					
	Powerhouse		Sluiceway		Spillway		Powerhouse		Sluiceway		Spillway	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
01	0	0	32	18	0	0	0	0	68	13	0	0
10	28	21	4	1	413	45	24	21	5	3	228	31
11	16	20	58	13	320	86	26	32	55	13	274	96
Total	46	41	94	32	733	131	50	53	128	29	502	127
Detection Probabilities												
P1	1.0	1.0	0.64	0.42	1.0	1.0	1.0	1.0	0.45	0.50	1.0	1.0
P2	0.36	0.49	0.93	0.93	0.44	0.66	0.52	0.60	0.92	0.81	0.55	0.76
P12	1.0	1.0	0.98	0.96	1.0	1.0	1.0	1.0	0.95	0.91	1.0	1.0

Capture History	**Chinook**											
	Occluded						Unoccluded					
	Powerhouse		Sluiceway		Spillway		Powerhouse		Sluiceway		Spillway	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
01	0	0	23	10	0	0	0	0	39	23	0	0
10	95	28	3	6	189	55	131	38	1	3	166	55
11	58	19	23	33	216	156	94	35	33	22	277	142
Total	153	47	49	49	405	211	225	73	73	48	443	197
Detection Probabilities												
P1	1.0	1.0	0.50	0.77	1.0	1.0	1.0	1.0	0.46	0.49	1.0	1.0
P2	0.38	0.40	0.88	0.85	0.53	0.74	0.42	0.48	0.97	0.88	0.62	0.72
P12	1.0	1.0	0.94	0.97	1.0	1.0	1.0	1.0	0.98	0.94	1.0	1.0

Table 6. Diel passage estimates of juvenile steelhead (STH) and yearling Chinook salmon (CH1) based on raw numbers of fish detected (Raw), after adjustments based on detection probabilities of each detection array (Adj) and the resulting difference (Diff). All numbers are percents.

	Estimate		Day			Night		
		Treatment	Raw	Adj	Diff	Raw	Adj	Diff
STH	FPE	Occluded	0.95	0.95	0.00	0.80	0.80	0.00
		Unoccluded	0.93	0.93	0.00	0.75	0.75	0.00
	SPE	Occluded	0.84	0.84	0.00	0.64	0.64	0.00
		Unoccluded	0.74	0.74	0.00	0.61	0.60	0.01
	SLPE	Occluded	0.11	0.11	0.00	0.16	0.16	0.00
		Unoccluded	0.19	0.19	0.00	0.14	0.15	-0.01
CH1	FPE	Occluded	0.71	0.71	0.00	0.80	0.80	0.00
		Unoccluded	0.66	0.66	0.00	0.70	0.70	0.00
	SPE	Occluded	0.63	0.62	0.01	0.65	0.65	0.00
		Unoccluded	0.57	0.57	0.00	0.56	0.55	0.01
	SLPE	Occluded	0.08	0.09	-0.01	0.15	0.15	0.00
		Unoccluded	0.09	0.09	0.00	0.14	0.15	-0.01

Table 7. Diel passage estimates of juvenile steelhead (STH) and yearling Chinook salmon (CH1) based on raw numbers of fish detected (Raw), after adjustments based on detection probabilities of each detection array (Adj) and the resulting difference (Diff). Based only on fish detected at MU1-MU3. All numbers are percents.

	Estimate		Day			Night		
		Treatment	Raw	Adj	Diff	Raw	Adj	Diff
STH	FPE	Occluded	0.94	0.94	0.00	0.79	0.80	-0.01
		Unoccluded	0.94	0.95	-0.01	0.87	0.88	-0.01
	SPE	Occluded	0.42	0.41	0.01	0.31	0.31	0.00
		Unoccluded	0.29	0.28	0.01	0.27	0.26	0.01
	SLPE	Occluded	0.52	0.53	-0.01	0.48	0.49	-0.01
		Unoccluded	0.65	0.67	-0.02	0.60	0.62	-0.02
CH1	FPE	Occluded	0.81	0.82	-0.01	0.81	0.82	-0.01
		Unoccluded	0.43	0.44	-0.01	0.69	0.70	-0.01
	SPE	Occluded	0.41	0.41	0.00	0.15	0.15	0.00
		Unoccluded	0.14	0.14	0.00	0.07	0.07	0.00
	SLPE	Occluded	0.40	0.41	-0.01	0.66	0.67	-0.01
		Unoccluded	0.29	0.30	-0.01	0.62	0.63	-0.01

Results from the Summer Study Period

Dam Operations

The mean hourly percent spill discharges at TDA during the summer were similar to the 40% spill proposed during the design phase of the study (Table 8, Appendix R). The mean hourly percent spill was 36% (range 0 to 77.6 %) during the day and 41.9% (range 28.0 to 79.5%) during the night through the summer study period 25 June through 13 July 2002. Mean hourly total discharge was 285 KCFS (range 141 to 466 KCFS) during the day and 262 KCFS (range 135 to 369 KCFS) at night. Figure 5 illustrates that while forebay elevation remained relatively stable throughout our study periods, there was a significant difference in temperature between the start and finish of the summer study period just as there was during the spring study period.

Number of Fish Released and Detected

A total of 4709 subyearling Chinook salmon were released at JDA during the summer study period (Table 9). The fish releases occurred at Rock Creek, through the JDA bypass outfall, and in the JDA tailrace from 25 June through 13 July. We completed our summer study period between the 23rd and 80th percentile of passage of subyearling Chinook salmon at JDA (Figure 6). Subyearling Chinook salmon from all releases combined had a mean fork length of 119 mm (range 107 to 151 mm) and a mean weight of 19 g (range 12 to 47 g). The mean fork length of all subyearling Chinook salmon sampled at the JDA Smolt Monitoring Facility during our study period was 104 mm (range 65 to 155 mm). Detailed summaries of all releases are presented in Appendices S through U. The mean tag-weight-to-body-weight ratio was 4.5 % (range 2.0 to 7.1%). Telemetry equipment at the dam detected 80% of the subyearling Chinook salmon released (Table 9).

Table 8. Mean hourly percentages of total discharge spilled and total hourly discharge (thousand cubic feet per second) at The Dalles Dam when upper portions of turbine intakes were occluded or unoccluded, 25 June through 13 July 2002. Blocks consisted of one 3-day treatment with turbine intakes on turbine units one through four partially occluded and a second 3-Day treatment without the intakes occluded. Day and night refers to the spill periods from 0530-2059 hours and 2100-0529 hours, respectively. Std=standard deviation.

		Percent hourly spill					
		Day			Night		
Block	**Treatment**	Mean	Std	Range	Mean	Std	Range
5	Occluded	37.6	11.7	29.6-76.3	47.1	18.5	28.0-77.1
5	Unoccluded	29.4	15.4	0.0-75.9	44.7	14.9	31.2-79.5
6	Occluded	36.6	3.0	30.8-42.0	39.7	3.9	30.8-49.8
6	Unoccluded	38.3	12.6	28.3-77.6	42.7	16.9	28.9-77.4
7	Occluded	36.8	3.5	30.7-42.7	38.5	2.4	32.9-41.8
7	Unoccluded	37.5	2.0	32.0-40.0	38.8	3.4	32.3-43.9

		Total hourly discharge					
		Day			Night		
Block	**Treatment**	Mean	Std	Range	Mean	Std	Range
5	Occluded	330.0	35.3	246.6-378.4	308.3	47.6	226.8-369.1
5	Unoccluded	301.0	36.1	236.7-354.7	288.9	29.1	248.1-352.0
6	Occluded	273.5	40.9	165.0-324.6	242.8	39.5	178.6-324.2
6	Unoccluded	325.4	45.3	257.8-466.5	298.9	27.7	243.9-345.9
7	Occluded	250.6	71.9	154.5-349.0	225.8	60.2	148.5-319.7
7	Unoccluded	229.7	40.4	141.0-299.7	209.6	50.5	134.9-297.3

Table 9. Numbers of radio-tagged subyearling Chinook salmon released at Rock Creek (JDR) above John Day Dam (JDA), in the JDA bypass facility (JBS), and in the JDA tailrace (JDT), and the percentages of fish detected by the radio-telemetry receivers at The Dalles Dam, summer 2002.

Release site	Number released	Percent detected
JDR	1779	75.1
JBS	1034	77.2
JDT	1896	85.8
Overall	4709	79.9

Arrival Time, Travel Time, and Approach Pattern

The hour of arrival at TDA of subyearling Chinook salmon was dispersed throughout the diel period but there was a peak from 1000 to 1800 hours that accounted for 60% of those detected (Figure 19). Median travel time from the Rock Creek release site to the TDA near-dam forebay was 34.7 h. The median travel times of subyearling Chinook salmon released at the JDA bypass and tailrace were 15.5 h and 14.0 h, respectively.

Analyses of fish detected on underwater antennas within 10 m of the dam showed both diel and treatment effects. Of the subyearling Chinook salmon arriving in the day during the occluded treatment, 61% were first detected at the powerhouse and 39% were first detected at the spillway, and during the unoccluded treatment in the day 67% were first detected at the powerhouse and 33% were first detected at the spillway (Figure 20). The distribution of arrival location was less affected by treatment at night as 43% were first detected at the powerhouse and 57% at the spillway during the occluded treatment while 45% were first detected at the powerhouse and 55% at the spillway during the unoccluded treatment. Figure 21 shows subyearling Chinook salmon approached the dam at greater depth at night and had less frequent first detections on the test unit antennas during the occluded treatment.

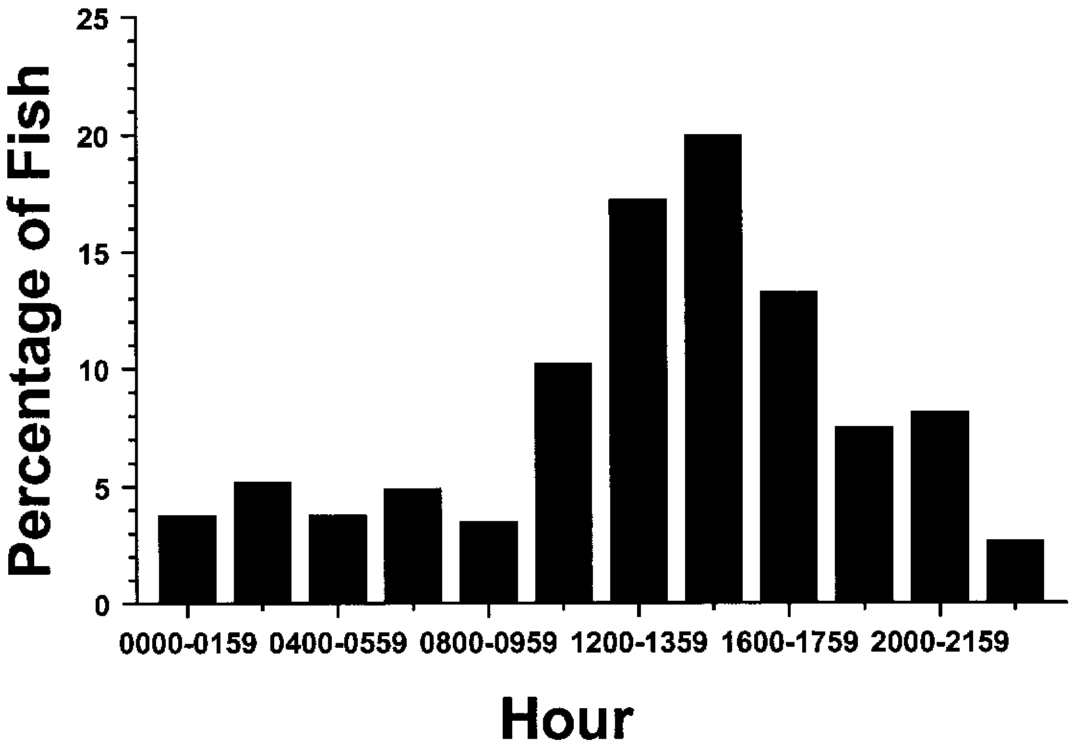

Figure 19. Diel distribution of radio-tagged subyearling Chinook salmon hour or arrival among 2-h intervals at The Dalles Dam, 25 June through 13 July 2002. Only fish detected within 10 m of main turbine units 1 through 4 were included. Sample size=1058.

The area where a fish was first detected was usually the same area where it passed the dam (Figure 22). For example, of all subyearling Chinook salmon first detected at MU1-MU4 during the occluded treatment, 69% passed the dam through MU1-MU4. However, during the unoccluded treatment, only 50% of those first detected at MU1-MU4 passed via this route. The only area where this detection/passage trend was not shown was at the sluiceway where fish first

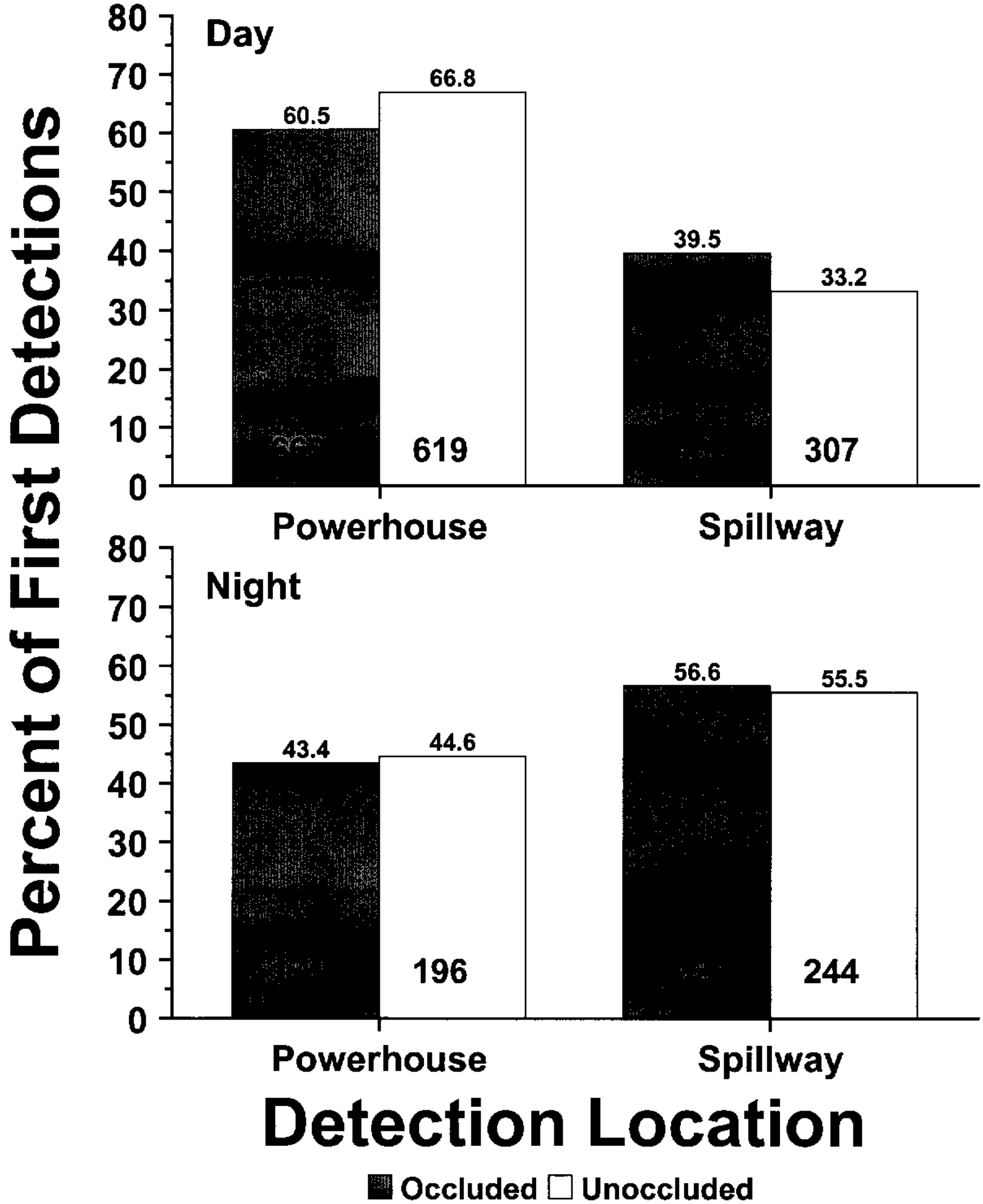

Figure 20. Diel percentage of subyearling Chinook salmon first detections at The Dalles Dam, summer 2002. Detections were in powerhouse and spillway forebay areas within 10m of the dam on underwater antenna arrays during occluded and unoccluded turbine intake treatments. Percentages are shown above bars. Sample sizes are shown within bars.

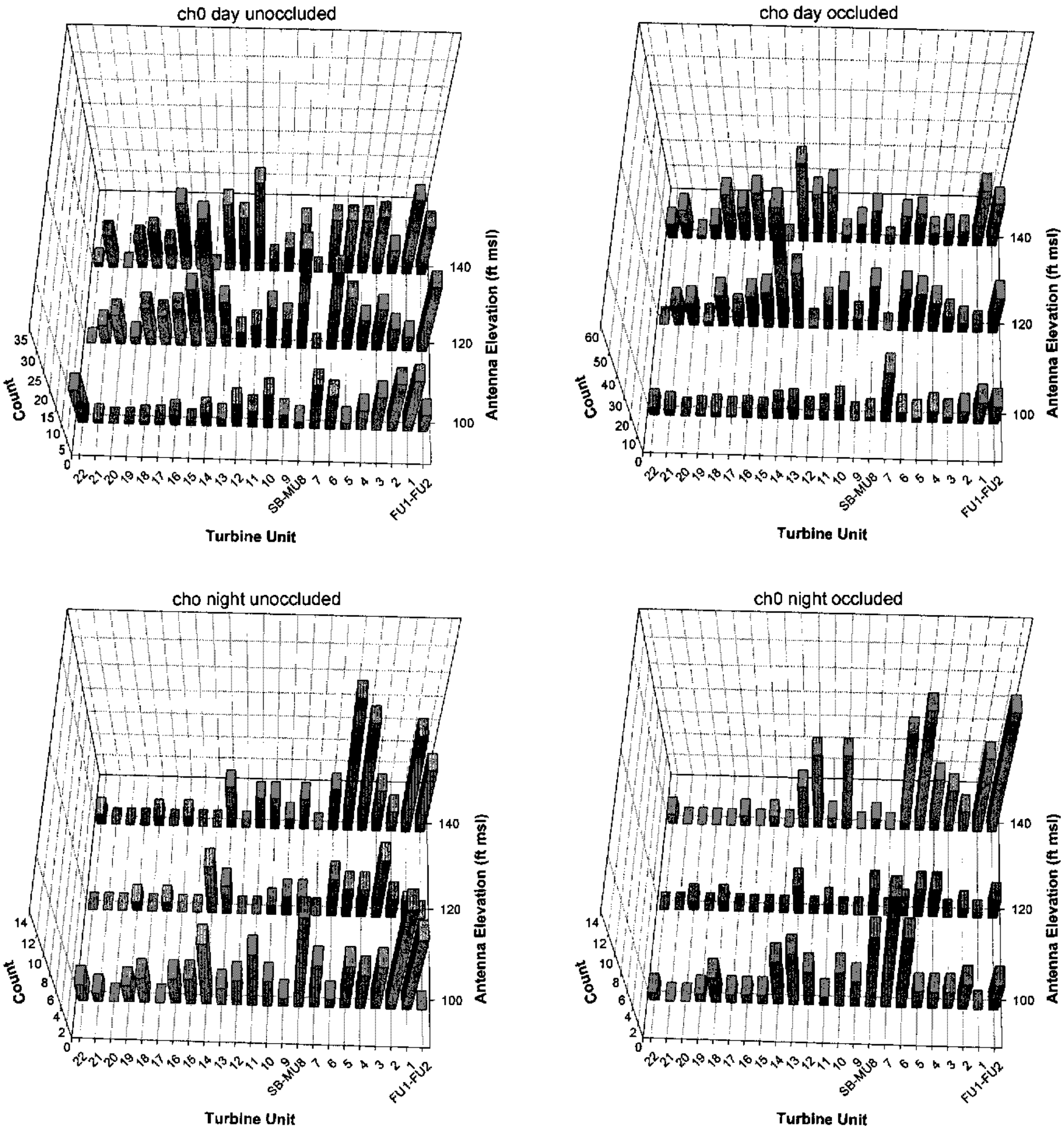

Figure 21. Numbers of radio-tagged subyearling Chinook salmon first detected at underwater antennas at the powerhouse of The Dalles Dam during day and night time periods within occluded and unoccluded treatments during summer 2002. Underwater antennas were located on piernoses between main turbine units at elevations 140, 120 and 100 ft msl. Turbine unit designations include combined areas at the two fish units (FU1-FU2) and between the piernose between main unit 9 and the service bay (between main units 8 and 9) and the service bay to the downstream piernose of main unit 8 (SB-MU8). All other turbine units indicated represent detections at the antennas affixed to the piernose immediately upstream of the unit.

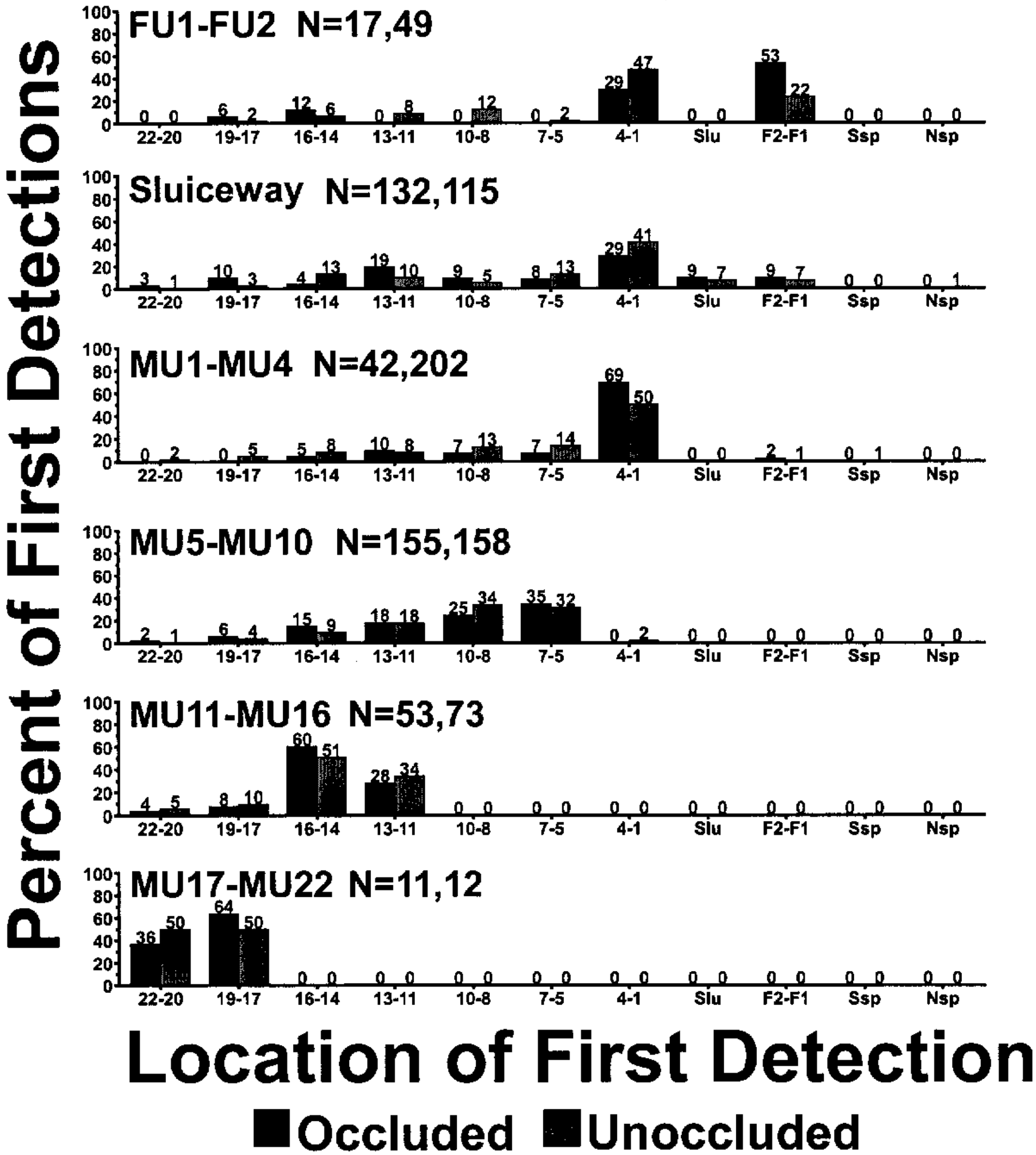

Figure 22. Percentage of radio-tagged subyearling Chinook salmon passing The Dalles Dam at the sluiceway, fish turbine 1 and 2 (FU1, FU2), main turbine units 1 through 4 (MU1-MU4), main turbine units 5 through 10 (MU5-MU10), main turbine units 11 through 16 (MU11-MU16), and main turbine units 17 through 22 (MU17-MU22) during occluded and unoccluded turbine intake treatments, summer 2002, that were first detected within 10 m of the dam main turbine units 1-22, fish turbine units (F2-F1), sluiceway (Slu), and north and south spillway (Nsp,Ssp). Numbers above bars are the percentage of fish first detected at each location. Sluiceway antennas detected only fish within the sluiceway. N=number of fish passing through each dam area detected on underwater antennas (occluded N, unoccluded N).

detected there were most likely to pass through MU1-MU4 regardless of treatment.

The occluded treatment resulted in lower turbine passage and higher sluiceway and spillway passage for subyearling Chinook salmon (Figure 23). The majority of subyearling Chinook salmon first detected at the piernose between MU3 and MU4 passed via the spillway during the occluded treatment but most passed through the turbines during the unoccluded treatment.

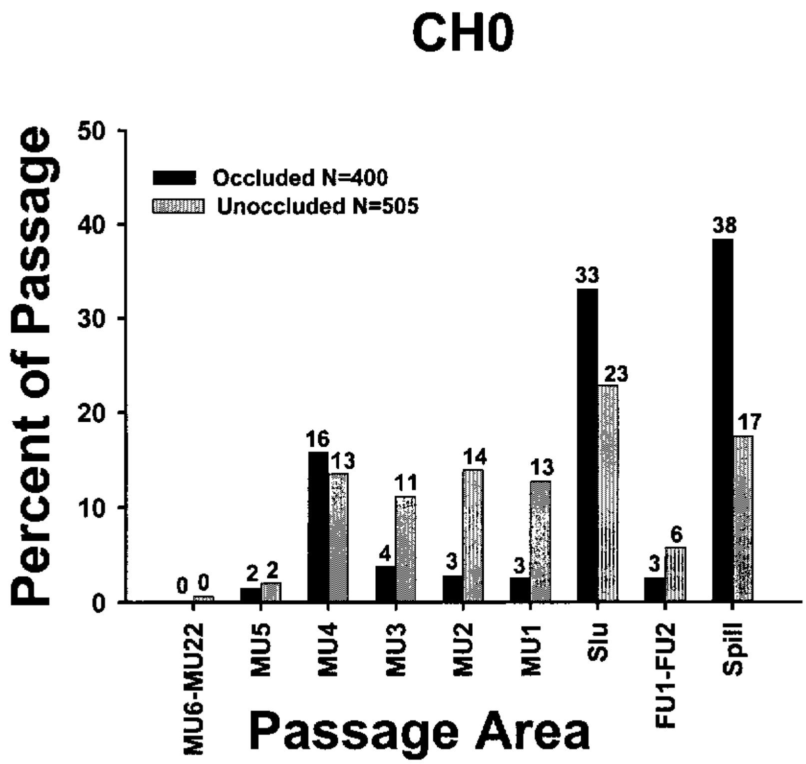

Figure 23. Passage locations of radio-tagged subyearling Chinook salmon detected on underwater antennas at the piernose between main unit 3 (MU3) and main unit 4 (MU4) during occluded and unoccluded treatments. Slu=sluiceway, FU1-FU2=fish units 1 and 2, Spill=spillway. The number above each bar indicates the percentage the bar represents.

Forebay Residence Times

The median forebay residence times for all subyearling Chinook salmon passing The Dalles Dam ranged from 0.02 to 0.10 h. The median residence time during the day was 0.10 h for the occluded treatment and 0.08 h for the unoccluded treatment. At night, the median residence time was 0.06 h for the occluded treatment and 0.03 h for the unoccluded treatment.

The median residence times of subyearling Chinook salmon detected at MU1-MU4 were significantly different between treatments during the night based on analysis of pooled blocks. The median residence times of these fish ranged from 0.08 h to 0.48 h (Figure 24). However, there were significant block differences during the day and they could not be pooled. Median residence times during the unoccluded treatments of blocks 5 and 7 were significantly shorter than those during the occluded treatment. The median residence times were always greater during the occluded treatment regardless of the diel period or block.

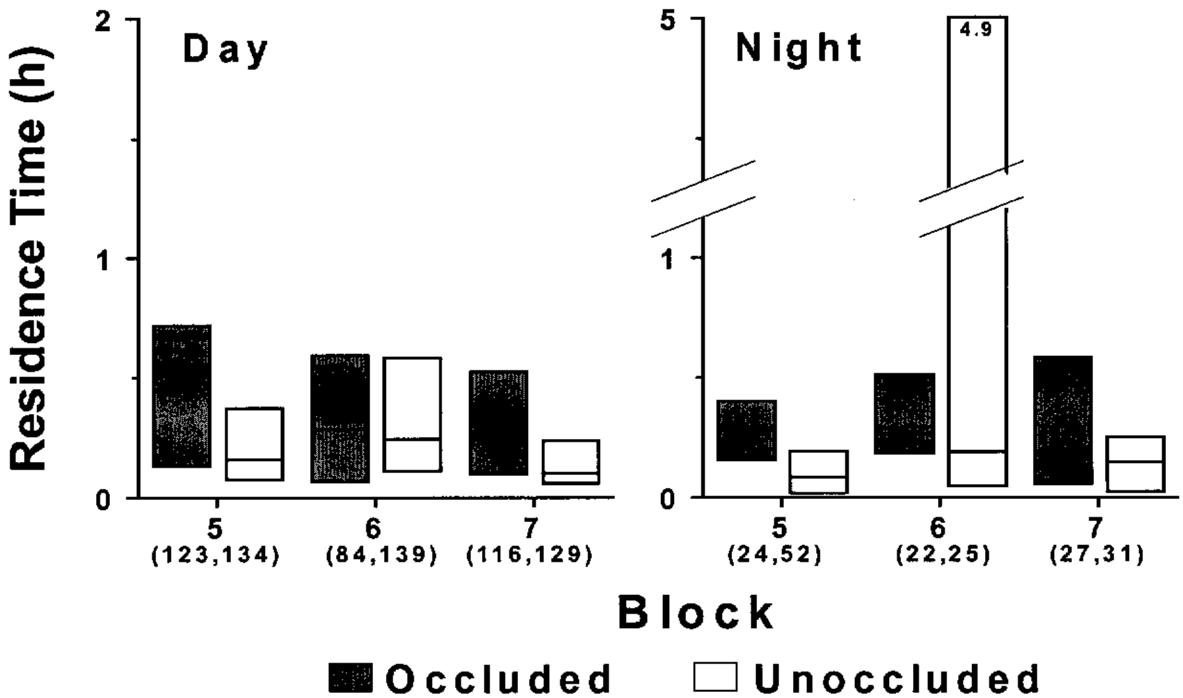

Figure 24. Twenty-fifth, 50th (median), and 75th percentiles (lower, middle, and upper horizontal lines on bars) of radio-tagged subyearling Chinook salmon forebay residence times (h) by diel time of arrival during occluded and unoccluded turbine intake treatments at The Dalles Dam, summer 2002. Only fish detected on underwater antennas at main turbine units 1 through 4 were included. Sample sizes are shown in parentheses

General Route and Time of Passage

The time of day that radio-tagged subyearling Chinook salmon detected at MU1-MU4 passed TDA was dispersed throughout the diel period, though there was a substantial peak occurring from 1200 to 1800 hours (Figure 25).

Diel differences in the area of passage for subyearling Chinook salmon detected at MU1-MU4 were evident during the occluded treatment, with proportionately more fish passing through the sluiceway and fewer via the spillway and FU1-MU5 at night (Figure 26).

Additionally, during the unoccluded treatment more subyearlings passed through the spillway during the day (21%) than at night (4%) with an opposite trend in passage via FU1-MU5. The passage trends are evident by block as well as with the blocks pooled.

For all radio-tagged fish, there was little diel difference among the areas of passage. There was much greater day passage overall and a difference between treatments was evident during this period. During the day, spillway passage was 64% during the occluded treatment but only 47% during the unoccluded treatment. Powerhouse passage was 27% during the occluded treatment and 45% during the unoccluded treatment. Passage at night was similar during each treatment. Appendix V contains passage data by block, treatment, diel period, and date.

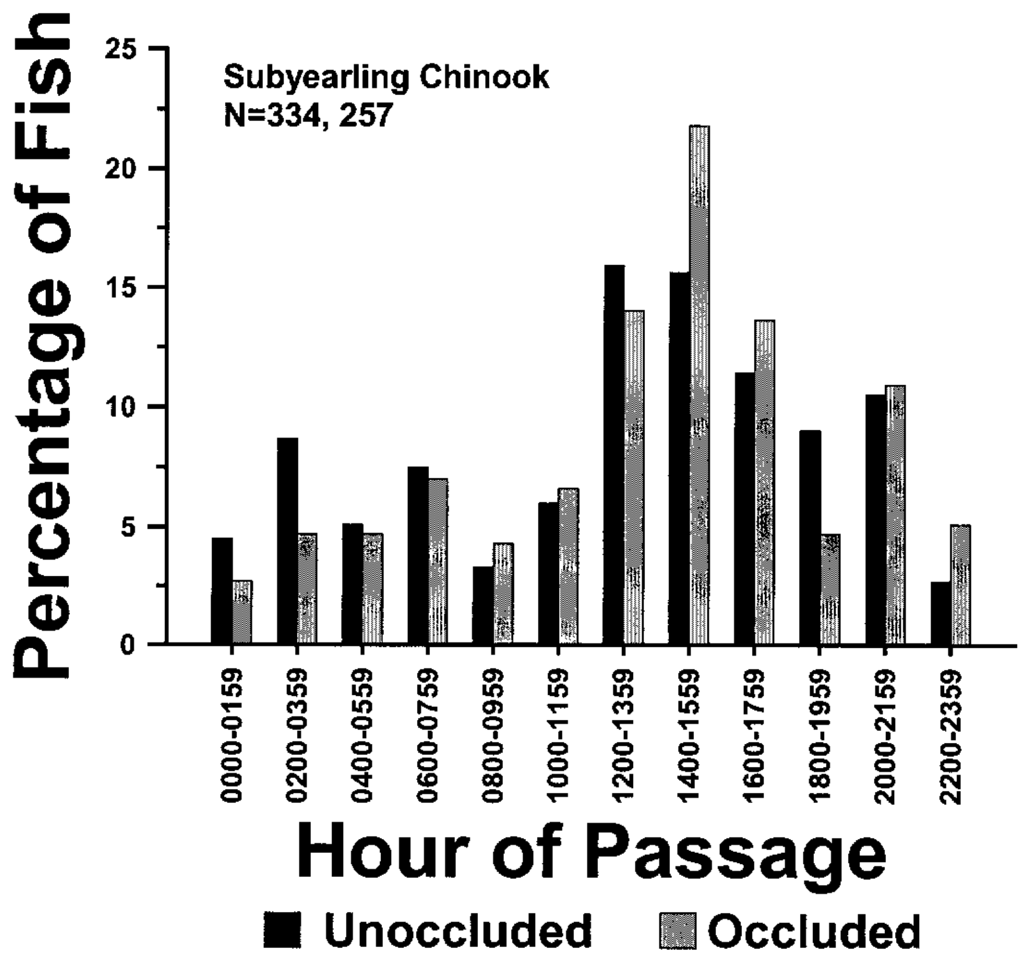

Figure 25. Diel distribution of radio-tagged subyearling Chinook salmon passage at The Dalles Dam during unoccluded and occluded treatments, 25 June through 13 July 2002. N = subyearling Chinook salmon sample size (unoccluded, occluded).

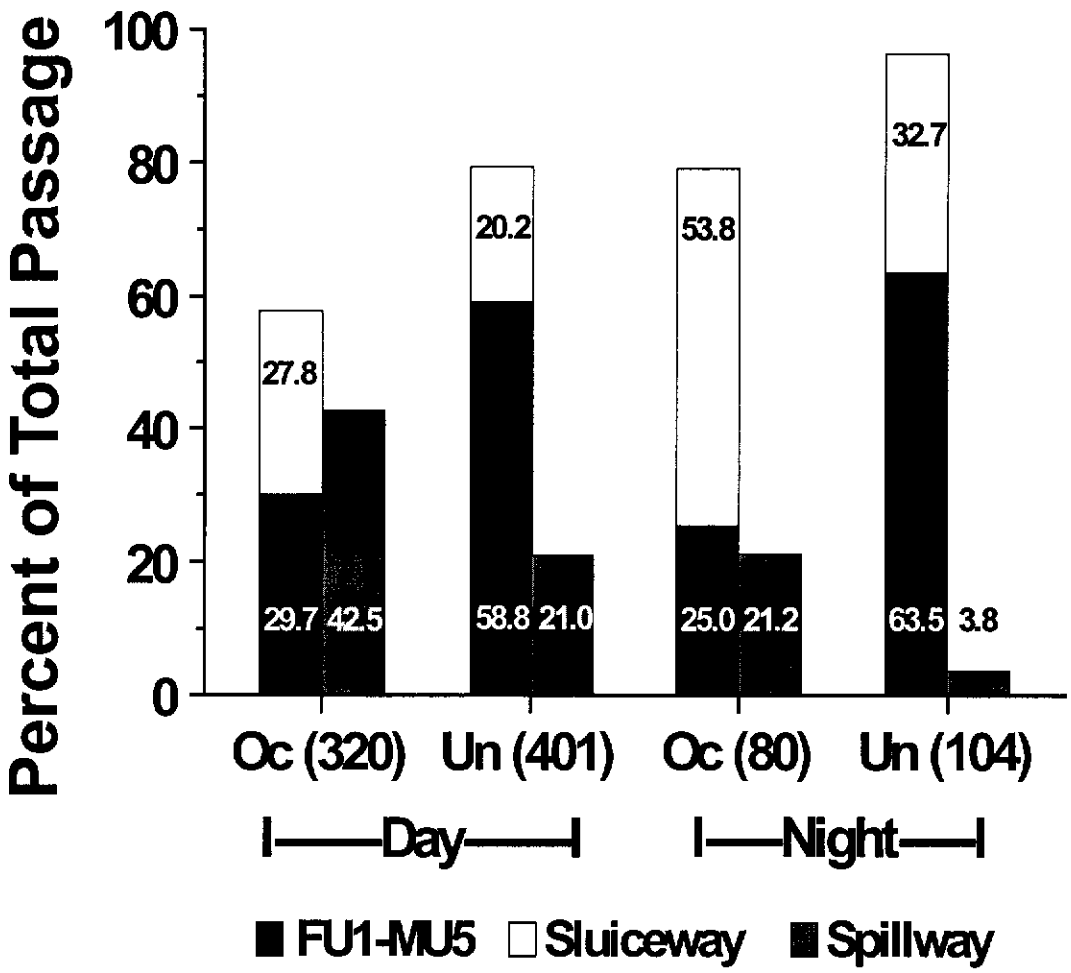

Figure 26. Percentage of radio-tagged subyearling Chinook salmon detected at main turbine units 1 through 4 that were detected passing through the turbines, sluiceway, or spillway at The Dalles Dam during occluded (Oc) and unoccluded (Un) turbine intake treatments, summer 2002. Passage percentages for each area and treatment are shown on or near bars. Day and Night refer to periods between 0531-2059 hours and 2100-0530 hours. Sample sizes are shown in parentheses.

Fish, Spill, and Sluiceway Passage Efficiencies

The FPE, SPE, and SLPE of the general population of subyearling Chinook salmon were 63, 55, and 8%. These results are based on total fish detected and do not take into account the occluded and unoccluded treatments.

The FPE, SPE and SLPE of subyearling Chinook salmon detected at MU1-MU4 were all higher during the occluded treatment regardless of diel period (Appendices W, X, and Y). This trend was evident with the test blocks analyzed separately and with the blocks pooled (Figure 27, Table 10). The difference in FPE between the occluded and unoccluded treatments of subyearling Chinook salmon was significant during both day and night (Chi-square, $P < 0.0001$, df=1). Therefore, turbine entrainment differences were also significant between treatments with more fish being entrained during the unoccluded treatment. However, the differences between treatments were greater at night than during the day. The FPE for subyearling Chinook salmon detected at MU1-MU4 was 70% for the occluded treatment and 41% for the unoccluded treatment during the day and showed little change at night with FPE's of 75 and 36% for the occluded and unoccluded treatments, respectively. The differences in SPE between treatments were not significant during the day or night and SLPE showed a significant difference for night passage only (Appendix X and Y). The SPE during the day was 42% during the occluded treatment and 21% during the unoccluded treatment. During the night the SPE was 21% during the occluded treatment and 4% during the unoccluded treatment. The SLPE during the day was 28% during the occluded treatment and 20% during the unoccluded treatment. During the night the SLPE was 54% during the occluded treatment and 33% during the unoccluded treatment.

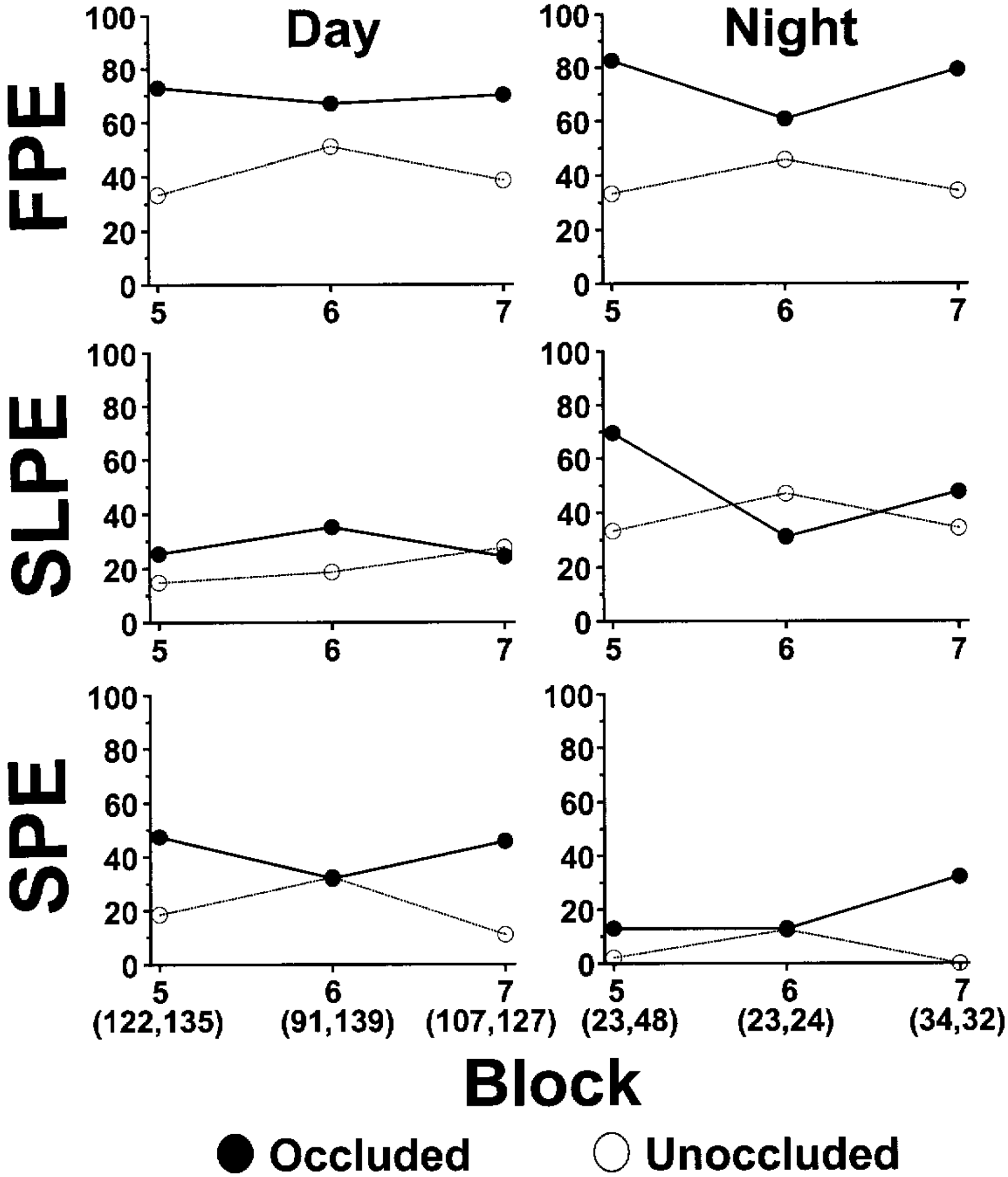

Figure 27. Fish passage efficiency (FPE), sluiceway passage efficiency (SLPE), and spill passage efficiency (SPE) of Subyearling Chinook salmon detected within 10 m of main turbine unit 1 through 4 during three study Blocks, 25 June through 13 July 2002. Sample sizes for occluded and unoccluded treatments are given in parentheses for each Block. All data are in percents.

Table 10. Diel passage estimates (Est) of subyearling Chinook salmon detected within 10 m of main turbine unit 1 through main turbine unit 4 during occluded and unoccluded turbine intake treatments at The Dalles Dam, 25 June through 13 July 2002. Diel period: Day = 0530-2059 hours, Night = 2100-0529 hours. FPE = fish passage efficiency. SPE = spill passage efficiency. SLPE = sluiceway passage efficiency. N=sample size. LRCI = likelihood ratio confidence interval.

Diel period	Passage metric	Occluded			Unoccluded		
		Est	95%LRCI	N	Est	95%LRCI	N
Day	FPE	70.3	61.9-77.9	320	41.1	33.6-49.0	401
	SPE	42.5	29.5-56.2	320	20.9	12.2-32.0	401
	SLPE	27.8	20.5-36.0	320	20.2	14.4-26.9	401
Night	FPE	75.0	64.8-83.6	80	36.5	27.7-46.0	104
	SPE	21.2	9.4-37.7	80	3.8	0.5-12.8	104
	SLPE	53.7	42.8-64.4	80	32.7	24.2-42.0	104

Spill Effectiveness

The spill effectiveness for subyearling Chinook salmon detected at the The Dalles Dam was 1.4:1. The ratio is based on all fish detected and is therefore unrelated to treatment comparisons.

Detection efficiencies

The detection efficiencies of the arrays at the powerhouse, spillway, and sluiceway were uniformly high. They ranged from 90% to 100% with the lowest detection efficiencies for both day and night occurring at the sluiceway (Table 11). The efficiencies of the forebay arrays were greater than the tailrace arrays, as indicated by the small incidence of "01" capture histories relative the "10" histories in most cases with the exception of the sluiceway where the trend was reversed. Most fish were detected on both arrays, as indicated by the large "11" capture histories relative to the "01" and "10" histories.

The adjusted passage estimates were calculated for the general population of fish detected as well as the subset of fish detected at MU1-MU4. The detection probabilities of the general population of fish were used to adjust the estimates of the fish detected at the test units, as it was not possible to determine probabilities of these fish separately. The differences in detection probabilities between the spillway, powerhouse and sluiceway arrays resulted in no difference in the passage index estimates of the general population of fish and a maximum of two percent difference for fish detected at MU1-MU4 (Tables 12 and 13).

Table 11. Diel capture histories and detection probabilities of telemetry detection arrays of subyearling Chinook salmon at the powerhouse, sluiceway and spillway at The Dalles Dam, summer 2002. See text for capture history and detection probability definitions.

Capture History	**Subyearling Chinook**											
	Occluded						Unoccluded					
	Powerhouse		Sluiceway		Spillway		Powerhouse		Sluiceway		Spillway	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
01	0	0	39	17	0	0	0	0	43	21	0	0
10	149	53	2	1	82	11	259	77	4	2	88	7
11	118	82	42	25	557	255	190	95	34	11	384	277
Total	267	135	83	43	639	266	449	172	81	34	472	284
	Detection Probabilities											
P1	1.0	1.0	0.52	0.59	1.00	1.00	1.0	1.0	0.44	0.34	1.00	1.00
P2	0.44	0.61	0.95	0.96	0.87	0.96	0.42	0.55	0.89	0.85	0.81	0.97
P12	1.0	1.0	0.98	0.98	1.00	1.00	1.0	1.0	0.94	0.90	1.00	1.00

Table 12. Diel passage estimates from subyearling Chinook salmon (CH0) based on raw numbers of fish detected (Raw), after adjustments based on detection probabilities of each detection array (Adj) and the resulting difference (Diff). All numbers are percents.

	Estimate		Day			Night		
		Treatment	Raw	Adj	Diff	Raw	Adj	Diff
CH0	FPE	Occluded	0.73	0.73	0.00	0.70	0.70	0.00
		Unoccluded	0.55	0.55	0.00	0.65	0.65	0.00
	SPE	Occluded	0.65	0.65	0.00	0.60	0.60	0.00
		Unoccluded	0.47	0.47	0.00	0.58	0.58	0.00
	SLPE	Occluded	0.08	0.08	0.00	0.10	0.10	0.00
		Unoccluded	0.08	0.08	0.00	0.07	0.07	0.00

Table 13. Diel passage estimates from subyearling Chinook salmon (CH0) based on raw numbers of fish detected (Raw), after adjustments based on detection probabilities of each detection array (Adj) and the resulting difference (Diff). Based only on fish detected at MU1-MU4. All numbers are percents.

	Estimate		Day			Night		
		Treatment	Raw	Adj	Diff	Raw	Adj	Diff
CH0	FPE	Occluded	0.70	0.70	0.00	0.75	0.75	0.00
		Unoccluded	0.41	0.42	-0.01	0.37	0.39	-0.02
	SPE	Occluded	0.42	0.42	0.00	0.21	0.21	0.00
		Unoccluded	0.21	0.21	0.00	0.04	0.04	0.00
	SLPE	Occluded	0.28	0.28	0.00	0.54	0.54	0.00
		Unoccluded	0.20	0.21	-0.01	0.33	0.35	-0.02

Discussion

The results of this study indicate the SGIDs used in 2002 had no measurable effect on turbine passage of wild juvenile steelhead, but significantly reduced turbine passage of yearling and subyearling Chinook salmon. The reduction in turbine passage of yearling Chinook salmon was greatest during the day, but turbine passage of subyearling Chinook salmon was reduced by 29% during the day and 38% at night. Reductions in turbine passage were accompanied by increases in spillway passage of yearling Chinook salmon and increases in both sluiceway and spillway passage of subyearling Chinook salmon. These results are based on an analysis restricted to fish that were detected within about 10 m of the piernoses between the test units, since the effect of the SGID's installed at main units 1 through 4 could be masked if examined in the context of turbine passage at the entire 23-unit powerhouse. Passage at main unit 4 was not included in the spring comparison between treatments, due to an equipment failure of the underwater antennas between main units 4 and 5.

The mechanism of reduced turbine passage was a cumulative reduction in turbine passage at several units as the fish moved westward along the powerhouse. This was evident in both Chinook salmon races, but was most notable in data from the subyearlings. The passage locations of fish detected at the powerhouse indicate that fish passing the powerhouse are typically first detected within about 10 m of the powerhouse near their unit of passage.

Data from radio telemetry and hydroacoustic methods indicate the overall FPE in 2002 was lower than in previous years of study. Estimates of FPE from a similar radio telemetry study during 40% spill in 2000 were 91% for juvenile hatchery steelhead, 85% for yearling Chinook salmon and 88% for subyearling Chinook salmon (Beeman et al. 2001a, 2001b). Point estimates from this study were 90, 70, and 63% for wild steelhead, yearling Chinook salmon and subyearling Chinook salmon, which are 1, 15 and 25% lower than in the radio telemetry study in 2000. Estimates from the 2002 hydroacoustic evaluation were similar to those from this study (69% spring, 50% summer; Johnson et al. 2003) and were also lower than estimates from a hydroacoustic study in 2000 (Moursund at al. 2001). We agree with the hypothesis of Johnson et al. (2003), which asserts this was likely due to changes in powerhouse turbine operating priorities between years. Operating turbines at The Dalles Dam are typically alternated along the powerhouse, but in 2003 main units 1 through 5 were block loaded to provide consistent conditions for the SGID tests. It appears that this resulted in greater turbine entrainment than in previous years and should be avoided in the future.

The results of this study indicate that SGID's benefit yearling and subyearling Chinook salmon, but the results of a hydroacoustic evaluation suggest the opposite. Johnson et al. (2003) reported the SGID's resulted in no statistical difference in turbine-entrained fish at main units 1 through 4 in the day during the spring ($P = 0.130$), a significant reduction in entrainment at night during the spring ($P = 0.027$) and significant *increases* in entrainment in the day ($P = 0.0014$) and night ($P = 0.002$) during the summer. The conflicting results of the studies are puzzling; there have commonly been differences in point estimates between the two methods, but the overall trends in the results have typically been similar (Ploskey et al. 2001). However, there were several differences between the studies in 2002 that may explain the conflicting results.

The differences in radio telemetry and hydroacoustic results during the spring may be due to the differences in species studied. The radio telemetry study was based on known yearling Chinook salmon and known wild steelhead and the hydroacoustic study was based on all species comprising the spring outmigration. The Smolt Index at John Day Dam, the nearest facility with a juvenile collection facility, indicates the spring outmigration was composed primarily of yearling Chinook salmon and sockeye salmon (*O. nerka*) and relatively few juvenile steelhead or coho salmon (*O. kisutch;* see Figure 6). Thus, the spring results of Johnson et al. (2003) included a large proportion of sockeye salmon (nearly 20%) and some coho salmon (about 5%), which were not part of this study. Sockeye salmon typically have greater turbine entrainment than yearling Chinook salmon, so it seems likely that their inclusion in the hydroacoustic evaluation may result in differences between the two studies (Johnson et al. (2003) discusses this further). There could also be differences in behavior of the fish used in this study due to the implantation of the transmitter, though the tag-weight-to-body-weight ratios were modest. Study dates during the spring were similar, except that radio telemetry data from wild steelhead were used in Block 8, which was included in the summer study period of the hydroacoustic study (Table 16).

The specific causes of the differences between summer results of this study and those of the hydroacoustic evaluation are not apparent. Each method produced consistent results in each block studied, but they indicated opposite effects. There were obvious differences in species composition and study dates, but these do not appear to explain the differences between the studies (Table 14). The hydroacoustic study was based on a mix of species until about 18 June (when subyearling Chinook salmon composed at least 80% of the fish at John Day Dam; data

Table 14. Dates, species and passage metrics used in evaluations of SGID's at The Dalles Dam in 2002. The hydroacoustic evaluation was done by Johnson et al. (2003). CH1= yearling Chinook salmon, CH0 = subyearling Chinook salmon, WST = wild juvenile steelhead, STH = juvenile steelhead (wild and hatchery origins pooled), SOC = sockeye salmon, COH = coho salmon.

	Dates	Blocks	Species	Metric
SPRING				
Radio Telemetry	5/02 to 5/31*	3 through 7*	CH1, WST	MU1 to MU3
Hydroacoustics	4/20 to 5/31	1 through 7	CH1, SOC, STH, COH	MU1 to MU4
SUMMER				
Radio Telemetry	6/25 to 7/12	12 through 14	CH0	MU1 to MU3
Hydroacoustics	6/01 to 7/06	8 through 14	CH0**	MU1 to MU4

* WST data continued until 6/6 (through Block 8)

** The outmigration at John Day Dam comprised 4% CH0 on 6/1 and 80% on 6/18.

from the University of Washington data access in real time website at http://www.cqs.washington.edu/dart/pass_rpt.html) and reported data from 01 June through 06 July (Blocks 1 through 13). This study was based on known subyearling Chinook salmon and used data from 25 June through 12 July (Blocks 12, 13 and 14). The varied species composition in early June does not appear to have affected the outcome of the hydroacoustic study, since these results were consistent among blocks, as were the data from this study.

In summary, the results from this study indicate use of the SGID's produced a statistically significant decrease in turbine entrainment of yearling Chinook salmon during the spring and subyearling Chinook salmon during summer, but no significant difference in turbine entrainment of juvenile wild steelhead. These results are dissimilar to those of the hydroacoustic evaluation of Johnson et al. (2003). Both studies described significant reductions in turbine passage during the spring, albeit one found the greatest benefit during the day (this study) and the other at night, but results from the summer are conflicting, with this study indicating the SGID's caused a significant reduction in turbine entrainment and the hydroacoustic evaluation indicating a significant increase in entrainment. Both research groups have explored possible causes for these differences in results, but neither has identified the reason (Gary Johnson, Battelle Memorial Institute, personal communication). The outcomes of these studies are not likely to result in further research or deployments of additional SGID's at The Dalles Dam. However, until another method of reducing turbine entrainment is developed, we suggest that the action resulting in the greatest benefit to the resource will be to deploy the existing SGID's during the spring and place them in the unoccluded position during the summer.

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Appendices

Appendix A. Spring treatment blocks for evaluating SGIDs at The Dalles Dam in 2002. Three-day treatments of both an occluded and an unoccluded condition comprise each six-day block.

Block	Date	Treatment
1	20-Apr	Occluded
1	21-Apr	Occluded
1	22-Apr	Occluded
1	23-Apr	Unoccluded
1	24-Apr	Unoccluded
1	25-Apr	Unoccluded
2	26-Apr	Occluded
2	27-Apr	Occluded
2	28-Apr	Occluded
2	29-Apr	Unoccluded
2	30-Apr	Unoccluded
2	1-May	Unoccluded
3	2-May	Unoccluded
3	3-May	Unoccluded
3	4-May	Unoccluded
3	5-May	Occluded
3	6-May	Occluded
3	7-May	Occluded
4	8-May	Occluded
4	9-May	Occluded
4	10-May	Occluded
4	11-May	Unoccluded
4	12-May	Unoccluded
4	13-May	Unoccluded
5	14-May	Occluded
5	15-May	Occluded
5	16-May	Occluded
5	17-May	Unoccluded
5	18-May	Unoccluded
5	19-May	Unoccluded
6	20-May	Unoccluded
6	21-May	Unoccluded
6	22-May	Unoccluded
6	23-May	Occluded
6	24-May	Occluded
6	25-May	Occluded

Appendix A continued

Block	Date	Treatment
7	26-May	Unoccluded
7	27-May	Unoccluded
7	28-May	Unoccluded
7	29-May	Occluded
7	30-May	Occluded
7	31-May	Occluded

Appendix B. Hourly spill discharge (Spill), total discharge (Totq), and percent spill discharge at The Dalles Dam by date, hour, block, and treatment, spring 2002. Discharge units are in thousand cubic feet per second. A "T" following the treatment indicates a transition period between treatments.

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
2 May	8	3	Unoccluded	83	207.6	40.0
2 May	9	3	Unoccluded	83	209.4	39.6
2 May	10	3	Unoccluded	95	245.4	38.7
2 May	11	3	Unoccluded	76	193.2	39.3
2 May	12	3	Unoccluded	76	191.2	39.7
2 May	13	3	Unoccluded	76	190.8	39.8
2 May	14	3	Unoccluded	68	190.4	35.7
2 May	15	3	Unoccluded	68	171.3	39.7
2 May	16	3	Unoccluded	68	171.3	39.7
2 May	17	3	Unoccluded	60	150.0	40.0
2 May	18	3	Unoccluded	60	148.5	40.4
2 May	19	3	Unoccluded	64	162.5	39.4
2 May	20	3	Unoccluded	74	192.3	38.5
2 May	21	3	Unoccluded	74	189.6	39.0
2 May	22	3	Unoccluded	74	187.7	39.4
2 May	23	3	Unoccluded	84	199.6	42.1
3 May	0	3	Unoccluded	94	241.3	39.0
3 May	1	3	Unoccluded	94	243.7	38.6
3 May	2	3	Unoccluded	95	254.5	37.3
3 May	3	3	Unoccluded	95	255.9	37.1
3 May	4	3	Unoccluded	95	258.6	36.7
3 May	5	3	Unoccluded	95	275.9	34.4
3 May	6	3	Unoccluded	95	264.5	35.9
3 May	7	3	Unoccluded	95	274.9	34.6
3 May	8	3	Unoccluded	95	277.0	34.3
3 May	9	3	Unoccluded	95	276.1	34.4
3 May	10	3	Unoccluded	95	269.5	35.3
3 May	11	3	Unoccluded	95	259.7	36.6
3 May	12	3	Unoccluded	95	244.0	38.9
3 May	13	3	Unoccluded	78	198.4	39.3
3 May	14	3	Unoccluded	78	201.5	38.7
3 May	15	3	Unoccluded	78	196.7	39.7
3 May	16	3	Unoccluded	78	196.5	39.7
3 May	17	3	Unoccluded	78	196.0	39.8
3 May	18	3	Unoccluded	90	226.3	39.8

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
3 May	19	3	Unoccluded	95	248.1	38.3
3 May	20	3	Unoccluded	95	269.6	35.2
3 May	21	3	Unoccluded	95	271.1	35.0
3 May	22	3	Unoccluded	95	267.5	35.5
3 May	23	3	Unoccluded	95	237.8	39.9
4 May	0	3	Unoccluded	95	247.4	38.4
4 May	1	3	Unoccluded	90	226.9	39.7
4 May	2	3	Unoccluded	90	228.0	39.5
4 May	3	3	Unoccluded	90	227.6	39.5
4 May	4	3	Unoccluded	90	227.9	39.5
4 May	5	3	Unoccluded	90	228.4	39.4
4 May	6	3	Unoccluded	90	239.6	37.6
4 May	7	3	Unoccluded	90	227.9	39.5
4 May	8	3	Unoccluded	90	229.2	39.3
4 May	9	3	Unoccluded	90	227.2	39.6
4 May	10	3	Unoccluded	79	198.8	39.7
4 May	11	3	Unoccluded	79	197.1	40.1
4 May	12	3	Unoccluded	79	197.1	40.1
4 May	13	3	Unoccluded	79	196.4	40.2
4 May	14	3	Unoccluded	79	202.1	39.1
4 May	15	3	Unoccluded	79	197.1	40.1
4 May	16	3	Unoccluded	79	197.7	40.0
4 May	17	3	Unoccluded	85	212.9	39.9
4 May	18	3	Unoccluded	94	233.1	40.3
4 May	19	3	Unoccluded	105	275.3	38.1
4 May	20	3	Unoccluded	105	280.9	37.4
4 May	21	3	Unoccluded	105	279.7	37.5
4 May	22	3	Unoccluded	105	275.8	38.1
4 May	23	3	Unoccluded	96	245.1	39.2
5 May	0	3	Unoccluded	96	238.1	40.3
5 May	1	3	Unoccluded	96	239.5	40.1
5 May	2	3	Unoccluded	96	241.2	39.8
5 May	3	3	Unoccluded	96	242.5	39.6
5 May	4	3	Unoccluded	96	243.0	39.5
5 May	5	3	Unoccluded	96	240.8	39.9
5 May	6	3	Unoccluded	96	242.0	39.7
5 May	7	3	Unoccluded	96	247.7	38.8
5 May	8	3	OccludedT	96	247.1	38.9

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
5 May	9	3	OccludedT	96	246.5	38.9
5 May	10	3	OccludedT	96	247.7	38.8
5 May	11	3	OccludedT	96	247.2	38.8
5 May	12	3	Occluded	96	246.0	39.0
5 May	13	3	Occluded	96	239.8	40.0
5 May	14	3	Occluded	80	196.4	40.7
5 May	15	3	Occluded	70	177.8	39.4
5 May	16	3	Occluded	70	172.4	40.6
5 May	17	3	Occluded	60	151.7	39.6
5 May	18	3	Occluded	60	154.8	38.8
5 May	19	3	Occluded	60	149.6	40.1
5 May	20	3	Occluded	66	167.7	39.4
5 May	21	3	Occluded	66	172.9	38.2
5 May	22	3	Occluded	76	189.1	40.2
5 May	23	3	Occluded	76	189.3	40.1
6 May	0	3	Occluded	76	190.2	40.0
6 May	1	3	Occluded	76	190.1	40.0
6 May	2	3	Occluded	76	190.3	39.9
6 May	3	3	Occluded	76	191.8	39.6
6 May	4	3	Occluded	76	195.0	39.0
6 May	5	3	Occluded	76	200.0	38.0
6 May	6	3	Occluded	80	218.1	36.7
6 May	7	3	Occluded	90	226.6	39.7
6 May	8	3	Occluded	90	224.0	40.2
6 May	9	3	Occluded	84	210.9	39.8
6 May	10	3	Occluded	84	207.6	40.5
6 May	11	3	Occluded	84	210.2	40.0
6 May	12	3	Occluded	84	210.0	40.0
6 May	13	3	Occluded	84	214.4	39.2
6 May	14	3	Occluded	84	220.0	38.2
6 May	15	3	Occluded	84	216.5	38.8
6 May	16	3	Occluded	78	205.5	38.0
6 May	17	3	Occluded	78	203.2	38.4
6 May	18	3	Occluded	90	228.1	39.5
6 May	19	3	Occluded	102	261.4	39.0
6 May	20	3	Occluded	102	263.6	38.7
6 May	21	3	Occluded	102	259.5	39.3
6 May	22	3	Occluded	90	222.4	40.5

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
6 May	23	3	Occluded	90	221.2	40.7
7 May	0	3	Occluded	90	215.3	41.8
7 May	1	3	Occluded	80	197.6	40.5
7 May	2	3	Occluded	80	200.2	40.0
7 May	3	3	Occluded	80	198.1	40.4
7 May	4	3	Occluded	80	200.5	39.9
7 May	5	3	Occluded	92	234.6	39.2
7 May	6	3	Occluded	102	268.5	38.0
7 May	7	3	Occluded	110	283.9	38.7
7 May	8	3	Occluded	110	280.9	39.2
7 May	9	3	Occluded	102	256.4	39.8
7 May	10	3	Occluded	102	243.0	42.0
7 May	11	3	Occluded	102	248.8	41.0
7 May	12	3	Occluded	102	246.2	41.4
7 May	13	3	Occluded	102	246.7	41.3
7 May	14	3	Occluded	88	226.3	38.9
7 May	15	3	Occluded	82	204.8	40.0
7 May	16	3	Occluded	68	172.1	39.5
7 May	17	3	Occluded	68	171.9	39.6
7 May	18	3	Occluded	80	199.0	40.2
7 May	19	3	Occluded	100	255.5	39.1
7 May	20	3	Occluded	110	277.7	39.6
7 May	21	3	Occluded	110	276.0	39.9
7 May	22	3	Occluded	110	272.3	40.4
7 May	23	3	Occluded	100	255.5	39.1
8 May	0	3	Occluded	96	240.3	40.0
8 May	1	3	Occluded	96	240.0	40.0
8 May	2	3	Occluded	96	239.4	40.1
8 May	3	3	Occluded	96	237.9	40.4
8 May	4	3	Occluded	96	241.8	39.7
8 May	5	3	Occluded	110	296.1	37.1
8 May	6	3	Occluded	110	340.5	32.3
8 May	7	3	Occluded	110	329.0	33.4
8 May	8	4	Occluded	110	306.1	35.9
8 May	9	4	Occluded	110	284.6	38.7
8 May	10	4	Occluded	110	291.5	37.7
8 May	11	4	Occluded	100	243.5	41.1
8 May	12	4	Occluded	92	239.8	38.4

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
8 May	13	4	Occluded	84	205.3	40.9
8 May	14	4	Occluded	84	209.0	40.2
8 May	15	4	Occluded	84	209.2	40.2
8 May	16	4	Occluded	84	209.6	40.1
8 May	17	4	Occluded	84	208.8	40.2
8 May	18	4	Occluded	84	218.9	38.4
8 May	19	4	Occluded	100	249.3	40.1
8 May	20	4	Occluded	100	253.2	39.5
8 May	21	4	Occluded	100	248.1	40.3
8 May	22	4	Occluded	100	250.1	40.0
8 May	23	4	Occluded	100	262.7	38.1
9 May	0	4	Occluded	100	246.7	40.5
9 May	1	4	Occluded	90	226.0	39.8
9 May	2	4	Occluded	90	226.3	39.8
9 May	3	4	Occluded	90	226.5	39.7
9 May	4	4	Occluded	90	227.0	39.6
9 May	5	4	Occluded	90	228.5	39.4
9 May	6	4	Occluded	90	230.9	39.0
9 May	7	4	Occluded	86	232.3	37.0
9 May	8	4	Occluded	86	231.1	37.2
9 May	9	4	Occluded	76	207.0	36.7
9 May	10	4	Occluded	76	201.3	37.8
9 May	11	4	Occluded	76	206.8	36.8
9 May	12	4	Occluded	76	205.6	37.0
9 May	13	4	Occluded	76	204.0	37.3
9 May	14	4	Occluded	76	208.0	36.5
9 May	15	4	Occluded	71	197.0	36.0
9 May	16	4	Occluded	60	171.2	35.0
9 May	17	4	Occluded	60	170.2	35.3
9 May	18	4	Occluded	66	185.9	35.5
9 May	19	4	Occluded	66	188.9	34.9
9 May	20	4	Occluded	76	206.6	36.8
9 May	21	4	Occluded	76	200.9	37.8
9 May	22	4	Occluded	76	195.8	38.8
9 May	23	4	Occluded	76	192.2	39.5
10 May	0	4	Occluded	76	195.8	38.8
10 May	1	4	Occluded	76	196.0	38.8
10 May	2	4	Occluded	76	192.2	39.5

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
10 May	3	4	Occluded	70	184.3	38.0
10 May	4	4	Occluded	70	187.4	37.4
10 May	5	4	Occluded	70	187.2	37.4
10 May	6	4	Occluded	70	204.7	34.2
10 May	7	4	Occluded	80	217.1	36.8
10 May	8	4	Occluded	80	212.2	37.7
10 May	9	4	Occluded	68	186.6	36.4
10 May	10	4	Occluded	68	189.8	35.8
10 May	11	4	Occluded	68	184.4	36.9
10 May	12	4	Occluded	68	188.2	36.1
10 May	13	4	Occluded	68	186.9	36.4
10 May	14	4	Occluded	68	180.7	37.6
10 May	15	4	Occluded	68	182.6	37.2
10 May	16	4	Occluded	68	177.2	38.4
10 May	17	4	Occluded	68	175.2	38.8
10 May	18	4	Occluded	68	173.1	39.3
10 May	19	4	Occluded	68	176.1	38.6
10 May	20	4	Occluded	68	175.4	38.8
10 May	21	4	Occluded	68	177.2	38.4
10 May	22	4	Occluded	68	178.8	38.0
10 May	23	4	Occluded	78	199.0	39.2
11 May	0	4	Occluded	78	192.6	40.5
11 May	1	4	Occluded	78	193.1	40.4
11 May	2	4	Occluded	78	195.6	39.9
11 May	3	4	Occluded	78	197.9	39.4
11 May	4	4	Occluded	78	199.3	39.1
11 May	5	4	Occluded	78	196.9	39.6
11 May	6	4	Occluded	78	201.7	38.7
11 May	7	4	Occluded	78	196.8	39.6
11 May	8	4	UnoccludedT	88	216.5	40.6
11 May	9	4	UnoccludedT	88	218.4	40.3
11 May	10	4	UnoccludedT	88	223.7	39.3
11 May	11	4	UnoccludedT	80	202.2	39.6
11 May	12	4	Unoccluded	80	198.8	40.2
11 May	13	4	Unoccluded	65	164.7	39.5
11 May	14	4	Unoccluded	65	165.2	39.3
11 May	15	4	Unoccluded	65	164.6	39.5
11 May	16	4	Unoccluded	76	190.7	39.9

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
11 May	17	4	Unoccluded	76	190.8	39.8
11 May	18	4	Unoccluded	92	233.5	39.4
11 May	19	4	Unoccluded	93	246.4	37.7
11 May	20	4	Unoccluded	93	247.3	37.6
11 May	21	4	Unoccluded	100	262.1	38.2
11 May	22	4	Unoccluded	88	227.4	38.7
11 May	23	4	Unoccluded	88	239.3	36.8
12 May	0	4	Unoccluded	88	231.1	38.1
12 May	1	4	Unoccluded	88	231.0	38.1
12 May	2	4	Unoccluded	88	230.3	38.2
12 May	3	4	Unoccluded	81	207.3	39.1
12 May	4	4	Unoccluded	81	207.6	39.0
12 May	5	4	Unoccluded	81	207.1	39.1
12 May	6	4	Unoccluded	72	184.6	39.0
12 May	7	4	Unoccluded	72	181.6	39.6
12 May	8	4	Unoccluded	64	161.9	39.5
12 May	9	4	Unoccluded	64	160.2	40.0
12 May	10	4	Unoccluded	64	167.4	38.2
12 May	11	4	Unoccluded	64	160.0	40.0
12 May	12	4	Unoccluded	64	161.7	39.6
12 May	13	4	Unoccluded	64	159.8	40.1
12 May	14	4	Unoccluded	64	158.2	40.5
12 May	15	4	Unoccluded	56	144.1	38.9
12 May	16	4	Unoccluded	56	142.2	39.4
12 May	17	4	Unoccluded	58	144.7	40.1
12 May	18	4	Unoccluded	58	143.2	40.5
12 May	19	4	Unoccluded	58	144.1	40.2
12 May	20	4	Unoccluded	66	164.5	40.1
12 May	21	4	Unoccluded	66	164.7	40.1
12 May	22	4	Unoccluded	66	166.4	39.7
12 May	23	4	Unoccluded	66	163.6	40.3
13 May	0	4	Unoccluded	66	164.6	40.1
13 May	1	4	Unoccluded	58	147.2	39.4
13 May	2	4	Unoccluded	58	148.0	39.2
13 May	3	4	Unoccluded	58	147.8	39.2
13 May	4	4	Unoccluded	58	154.2	37.6
13 May	5	4	Unoccluded	58	147.9	39.2
13 May	6	4	Unoccluded	68	174.6	38.9

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
13 May	7	4	Unoccluded	76	196.7	38.6
13 May	8	4	Unoccluded	85	219.4	38.7
13 May	9	4	Unoccluded	85	222.3	38.2
13 May	10	4	Unoccluded	98	247.0	39.7
13 May	11	4	Unoccluded	98	255.8	38.3
13 May	12	4	Unoccluded	102	267.9	38.1
13 May	13	4	Unoccluded	102	264.0	38.6
13 May	14	4	Unoccluded	102	264.1	38.6
13 May	15	4	Unoccluded	90	235.8	38.2
13 May	16	4	Unoccluded	90	230.4	39.1
13 May	17	4	Unoccluded	90	230.5	39.0
13 May	18	4	Unoccluded	90	230.0	39.1
13 May	19	4	Unoccluded	90	233.4	38.6
13 May	20	4	Unoccluded	90	230.7	39.0
13 May	21	4	Unoccluded	90	231.7	38.8
13 May	22	4	Unoccluded	64	152.6	41.9
13 May	23	4	Unoccluded	59	147.8	39.9
14 May	0	4	Unoccluded	59	149.0	39.6
14 May	1	4	Unoccluded	68	169.7	40.1
14 May	2	4	Unoccluded	68	168.3	40.4
14 May	3	4	Unoccluded	68	170.0	40.0
14 May	4	4	Unoccluded	68	175.7	38.7
14 May	5	4	Unoccluded	68	171.2	39.7
14 May	6	4	Unoccluded	68	179.9	37.8
14 May	7	4	Unoccluded	88	223.6	39.4
14 May	8	5	OccludedT	94	232.6	40.4
14 May	9	5	OccludedT	94	231.9	40.5
14 May	10	5	OccludedT	94	236.2	39.8
14 May	11	5	OccludedT	86	209.8	41.0
14 May	12	5	Occluded	78	199.5	39.1
14 May	13	5	Occluded	78	199.0	39.2
14 May	14	5	Occluded	78	198.7	39.3
14 May	15	5	Occluded	78	199.0	39.2
14 May	16	5	Occluded	78	201.2	38.8
14 May	17	5	Occluded	83	217.9	38.1
14 May	18	5	Occluded	91	226.8	40.1
14 May	19	5	Occluded	91	235.2	38.7
14 May	20	5	Occluded	91	237.3	38.3

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
14 May	21	5	Occluded	91	227.9	39.9
14 May	22	5	Occluded	71	185.7	38.2
14 May	23	5	Occluded	71	187.7	37.8
15 May	0	5	Occluded	64	163.9	39.0
15 May	1	5	Occluded	64	153.9	41.6
15 May	2	5	Occluded	64	155.3	41.2
15 May	3	5	Occluded	64	157.5	40.6
15 May	4	5	Occluded	64	164.3	39.0
15 May	5	5	Occluded	72	178.2	40.4
15 May	6	5	Occluded	88	216.7	40.6
15 May	7	5	Occluded	96	245.8	39.1
15 May	8	5	Occluded	96	246.3	39.0
15 May	9	5	Occluded	96	247.8	38.7
15 May	10	5	Occluded	96	244.9	39.2
15 May	11	5	Occluded	96	246.4	39.0
15 May	12	5	Occluded	86	228.4	37.7
15 May	13	5	Occluded	86	228.8	37.6
15 May	14	5	Occluded	86	226.0	38.1
15 May	15	5	Occluded	76	201.8	37.7
15 May	16	5	Occluded	76	203.8	37.3
15 May	17	5	Occluded	76	205.6	37.0
15 May	18	5	Occluded	86	230.8	37.3
15 May	19	5	Occluded	86	228.2	37.7
15 May	20	5	Occluded	90	230.4	39.1
15 May	21	5	Occluded	90	225.5	39.9
15 May	22	5	Occluded	90	229.3	39.2
15 May	23	5	Occluded	80	208.7	38.3
16 May	0	5	Occluded	80	197.4	40.5
16 May	1	5	Occluded	68	172.1	39.5
16 May	2	5	Occluded	68	168.9	40.3
16 May	3	5	Occluded	68	169.5	40.1
16 May	4	5	Occluded	68	174.8	38.9
16 May	5	5	Occluded	68	170.0	40.0
16 May	6	5	Occluded	68	168.4	40.4
16 May	7	5	Occluded	68	169.2	40.2
16 May	8	5	Occluded	68	171.2	39.7
16 May	9	5	Occluded	72	181.3	39.7
16 May	10	5	Occluded	72	178.4	40.4

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
16 May	11	5	Occluded	72	179.1	40.2
16 May	12	5	Occluded	72	181.4	39.7
16 May	13	5	Occluded	72	180.3	39.9
16 May	14	5	Occluded	72	181.1	39.8
16 May	15	5	Occluded	76	188.8	40.3
16 May	16	5	Occluded	76	188.4	40.3
16 May	17	5	Occluded	76	193.2	39.3
16 May	18	5	Occluded	84	207.9	40.4
16 May	19	5	Occluded	80	207.4	38.6
16 May	20	5	Occluded	80	208.1	38.4
16 May	21	5	Occluded	80	208.5	38.4
16 May	22	5	Occluded	80	215.6	37.1
16 May	23	5	Occluded	80	217.2	36.8
17 May	0	5	Occluded	88	238.3	36.9
17 May	1	5	Occluded	88	236.1	37.3
17 May	2	5	Occluded	88	232.5	37.8
17 May	3	5	Occluded	80	218.5	36.6
17 May	4	5	Occluded	80	213.5	37.5
17 May	5	5	Occluded	80	210.7	38.0
17 May	6	5	Occluded	80	216.1	37.0
17 May	7	5	Occluded	76	201.6	37.7
17 May	8	5	UnoccludedT	76	197.2	38.5
17 May	9	5	UnoccludedT	85	216.2	39.3
17 May	10	5	UnoccludedT	85	217.7	39.0
17 May	11	5	UnoccludedT	85	217.5	39.1
17 May	12	5	Unoccluded	82	210.1	39.0
17 May	13	5	Unoccluded	76	204.9	37.1
17 May	14	5	Unoccluded	74	189.7	39.0
17 May	15	5	Unoccluded	71	191.0	37.2
17 May	16	5	Unoccluded	71	208.7	34.0
17 May	17	5	Unoccluded	88	239.4	36.8
17 May	18	5	Unoccluded	99	261.4	37.9
17 May	19	5	Unoccluded	100	265.2	37.7
17 May	20	5	Unoccluded	100	240.8	41.5
17 May	21	5	Unoccluded	100	262.0	38.2
17 May	22	5	Unoccluded	100	254.7	39.3
17 May	23	5	Unoccluded	100	248.9	40.2
18 May	0	5	Unoccluded	100	244.0	41.0

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
18 May	1	5	Unoccluded	92	238.1	38.6
18 May	2	5	Unoccluded	92	236.2	39.0
18 May	3	5	Unoccluded	92	236.6	38.9
18 May	4	5	Unoccluded	92	237.1	38.8
18 May	5	5	Unoccluded	92	236.9	38.8
18 May	6	5	Unoccluded	84	225.5	37.3
18 May	7	5	Unoccluded	84	230.1	36.5
18 May	8	5	Unoccluded	78	214.6	36.3
18 May	9	5	Unoccluded	76	209.4	36.3
18 May	10	5	Unoccluded	70	190.5	36.7
18 May	11	5	Unoccluded	63	172.6	36.5
18 May	12	5	Unoccluded	63	172.0	36.6
18 May	13	5	Unoccluded	63	169.8	37.1
18 May	14	5	Unoccluded	63	172.0	36.6
18 May	15	5	Unoccluded	63	167.2	37.7
18 May	16	5	Unoccluded	63	169.0	37.3
18 May	17	5	Unoccluded	63	181.2	34.8
18 May	18	5	Unoccluded	72	186.2	38.7
18 May	19	5	Unoccluded	72	191.8	37.5
18 May	20	5	Unoccluded	72	191.6	37.6
18 May	21	5	Unoccluded	72	191.7	37.6
18 May	22	5	Unoccluded	72	198.7	36.2
18 May	23	5	Unoccluded	72	197.2	36.5
19 May	0	5	Unoccluded	80	211.7	37.8
19 May	1	5	Unoccluded	80	211.2	37.9
19 May	2	5	Unoccluded	80	211.6	37.8
19 May	3	5	Unoccluded	80	211.6	37.8
19 May	4	5	Unoccluded	80	212.7	37.6
19 May	5	5	Unoccluded	80	210.8	38.0
19 May	6	5	Unoccluded	80	212.8	37.6
19 May	7	5	Unoccluded	80	210.3	38.0
19 May	8	5	Unoccluded	80	211.5	37.8
19 May	9	5	Unoccluded	80	210.2	38.1
19 May	10	5	Unoccluded	80	210.0	38.1
19 May	11	5	Unoccluded	84	214.4	39.2
19 May	12	5	Unoccluded	84	213.3	39.4
19 May	13	5	Unoccluded	84	212.1	39.6
19 May	14	5	Unoccluded	80	201.1	39.8

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
19 May	15	5	Unoccluded	80	203.3	39.4
19 May	16	5	Unoccluded	80	201.9	39.6
19 May	17	5	Unoccluded	80	206.4	38.8
19 May	18	5	Unoccluded	86	216.8	39.7
19 May	19	5	Unoccluded	92	239.1	38.5
19 May	20	5	Unoccluded	100	253.1	39.5
19 May	21	5	Unoccluded	100	244.0	41.0
19 May	22	5	Unoccluded	84	220.6	38.1
19 May	23	5	Unoccluded	74	190.6	38.8
20 May	0	5	Unoccluded	74	186.4	39.7
20 May	1	5	Unoccluded	74	186.3	39.7
20 May	2	5	Unoccluded	74	186.0	39.8
20 May	3	5	Unoccluded	74	188.0	39.4
20 May	4	5	Unoccluded	74	186.7	39.6
20 May	5	5	Unoccluded	74	187.0	39.6
20 May	6	5	Unoccluded	80	202.4	39.5
20 May	7	5	Unoccluded	92	233.7	39.4
20 May	8	6	Unoccluded	96	241.9	39.7
20 May	9	6	Unoccluded	96	242.4	39.6
20 May	10	6	Unoccluded	96	241.7	39.7
20 May	11	6	Unoccluded	90	228.9	39.3
20 May	12	6	Unoccluded	88	223.5	39.4
20 May	13	6	Unoccluded	88	224.2	39.3
20 May	14	6	Unoccluded	84	215.5	39.0
20 May	15	6	Unoccluded	84	219.8	38.2
20 May	16	6	Unoccluded	88	224.7	39.2
20 May	17	6	Unoccluded	85	225.0	37.8
20 May	18	6	Unoccluded	85	232.4	36.6
20 May	19	6	Unoccluded	85	240.1	35.4
20 May	20	6	Unoccluded	85	249.9	34.0
20 May	21	6	Unoccluded	85	249.0	34.1
20 May	22	6	Unoccluded	85	251.9	33.7
20 May	23	6	Unoccluded	85	234.7	36.2
21 May	0	6	Unoccluded	85	241.5	35.2
21 May	1	6	Unoccluded	85	243.1	35.0
21 May	2	6	Unoccluded	85	236.6	35.9
21 May	3	6	Unoccluded	85	241.5	35.2
21 May	4	6	Unoccluded	85	242.6	35.0

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
21 May	5	6	Unoccluded	85	244.4	34.8
21 May	6	6	Unoccluded	106	269.9	39.3
21 May	7	6	Unoccluded	96	264.6	36.3
21 May	8	6	Unoccluded	85	264.2	32.2
21 May	9	6	Unoccluded	85	262.0	32.4
21 May	10	6	Unoccluded	85	278.8	30.5
21 May	11	6	Unoccluded	85	279.7	30.4
21 May	12	6	Unoccluded	85	277.2	30.7
21 May	13	6	Unoccluded	85	258.3	32.9
21 May	14	6	Unoccluded	85	259.4	32.8
21 May	15	6	Unoccluded	85	249.5	34.1
21 May	16	6	Unoccluded	85	267.2	31.8
21 May	17	6	Unoccluded	85	266.6	31.9
21 May	18	6	Unoccluded	85	268.0	31.7
21 May	19	6	Unoccluded	85	258.7	32.9
21 May	20	6	Unoccluded	85	264.9	32.1
21 May	21	6	Unoccluded	85	264.4	32.1
21 May	22	6	Unoccluded	85	241.9	35.1
21 May	23	6	Unoccluded	85	212.4	40.0
22 May	0	6	Unoccluded	85	214.3	39.7
22 May	1	6	Unoccluded	85	256.5	33.1
22 May	2	6	Unoccluded	85	277.1	30.7
22 May	3	6	Unoccluded	85	284.8	29.8
22 May	4	6	Unoccluded	85	287.9	29.5
22 May	5	6	Unoccluded	85	291.4	29.2
22 May	6	6	Unoccluded	85	289.9	29.3
22 May	7	6	Unoccluded	85	306.1	27.8
22 May	8	6	Unoccluded	85	300.2	28.3
22 May	9	6	Unoccluded	85	288.2	29.5
22 May	10	6	Unoccluded	85	263.8	32.2
22 May	11	6	Unoccluded	85	248.8	34.2
22 May	12	6	Unoccluded	85	240.6	35.3
22 May	13	6	Unoccluded	85	247.6	34.3
22 May	14	6	Unoccluded	85	263.0	32.3
22 May	15	6	Unoccluded	100	252.2	39.7
22 May	16	6	Unoccluded	100	250.4	39.9
22 May	17	6	Unoccluded	100	250.1	40.0
22 May	18	6	Unoccluded	100	253.9	39.4

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
22 May	19	6	Unoccluded	100	295.6	33.8
22 May	20	6	Unoccluded	100	308.1	32.5
22 May	21	6	Unoccluded	100	308.9	32.4
22 May	22	6	Unoccluded	100	304.3	32.9
22 May	23	6	Unoccluded	100	280.5	35.7
23 May	0	6	Unoccluded	100	262.1	38.2
23 May	1	6	Unoccluded	100	265.3	37.7
23 May	2	6	Unoccluded	100	261.0	38.3
23 May	3	6	Unoccluded	100	255.9	39.1
23 May	4	6	Unoccluded	100	254.6	39.3
23 May	5	6	Unoccluded	100	258.5	38.7
23 May	6	6	Unoccluded	100	257.9	38.8
23 May	7	6	Unoccluded	100	256.4	39.0
23 May	8	6	OccludedT	100	258.4	38.7
23 May	9	6	OccludedT	100	257.5	38.8
23 May	10	6	OccludedT	100	251.8	39.7
23 May	11	6	OccludedT	100	262.1	38.2
23 May	12	6	Occluded	100	263.8	37.9
23 May	13	6	Occluded	100	261.5	38.2
23 May	14	6	Occluded	100	251.5	39.8
23 May	15	6	Occluded	100	259.6	38.5
23 May	16	6	Occluded	100	249.7	40.0
23 May	17	6	Occluded	100	255.1	39.2
23 May	18	6	Occluded	105	263.2	39.9
23 May	19	6	Occluded	105	264.9	39.6
23 May	20	6	Occluded	110	277.7	39.6
23 May	21	6	Occluded	110	277.6	39.6
23 May	22	6	Occluded	110	267.3	41.2
23 May	23	6	Occluded	104	261.4	39.8
24 May	0	6	Occluded	104	260.0	40.0
24 May	1	6	Occluded	104	262.1	39.7
24 May	2	6	Occluded	104	261.5	39.8
24 May	3	6	Occluded	104	264.9	39.3
24 May	4	6	Occluded	104	261.7	39.7
24 May	5	6	Occluded	104	262.2	39.7
24 May	6	6	Occluded	110	276.5	39.8
24 May	7	6	Occluded	110	280.6	39.2
24 May	8	6	Occluded	110	279.3	39.4

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
24 May	9	6	Occluded	110	274.1	40.1
24 May	10	6	Occluded	110	264.8	41.5
24 May	11	6	Occluded	110	273.5	40.2
24 May	12	6	Occluded	110	275.7	39.9
24 May	13	6	Occluded	110	273.7	40.2
24 May	14	6	Occluded	110	276.9	39.7
24 May	15	6	Occluded	110	271.0	40.6
24 May	16	6	Occluded	110	268.7	40.9
24 May	17	6	Occluded	110	271.6	40.5
24 May	18	6	Occluded	115	291.9	39.4
24 May	19	6	Occluded	115	294.3	39.1
24 May	20	6	Occluded	115	298.9	38.5
24 May	21	6	Occluded	115	300.9	38.2
24 May	22	6	Occluded	115	293.7	39.2
24 May	23	6	Occluded	115	280.2	41.0
25 May	0	6	Occluded	105	262.3	40.0
25 May	1	6	Occluded	100	250.6	39.9
25 May	2	6	Occluded	100	252.1	39.7
25 May	3	6	Occluded	100	251.1	39.8
25 May	4	6	Occluded	100	252.4	39.6
25 May	5	6	Occluded	100	250.1	40.0
25 May	6	6	Occluded	104	261.6	39.8
25 May	7	6	Occluded	104	263.1	39.5
25 May	8	6	Occluded	104	261.3	39.8
25 May	9	6	Occluded	104	254.7	40.8
25 May	10	6	Occluded	92	236.7	38.9
25 May	11	6	Occluded	92	231.8	39.7
25 May	12	6	Occluded	92	230.1	40.0
25 May	13	6	Occluded	92	229.6	40.1
25 May	14	6	Occluded	92	236.6	38.9
25 May	15	6	Occluded	92	232.2	39.6
25 May	16	6	Occluded	95	241.3	39.4
25 May	17	6	Occluded	95	243.9	39.0
25 May	18	6	Occluded	95	243.6	39.0
25 May	19	6	Occluded	95	244.6	38.8
25 May	20	6	Occluded	95	243.0	39.1
25 May	21	6	Occluded	85	232.4	36.6
25 May	22	6	Occluded	85	226.7	37.5

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
25 May	23	6	Occluded	85	217.4	39.1
26 May	0	6	Occluded	85	219.8	38.7
26 May	1	6	Occluded	85	219.6	38.7
26 May	2	6	Occluded	96	236.7	40.6
26 May	3	6	Occluded	100	244.3	40.9
26 May	4	6	Occluded	100	249.8	40.0
26 May	5	6	Occluded	100	258.7	38.7
26 May	6	6	Occluded	100	259.4	38.6
26 May	7	6	Occluded	100	261.1	38.3
26 May	8	7	UnoccludedT	100	259.8	38.5
26 May	9	7	UnoccludedT	100	257.3	38.9
26 May	10	7	UnoccludedT	100	251.5	39.8
26 May	11	7	UnoccludedT	100	251.2	39.8
26 May	12	7	Unoccluded	100	248.9	40.2
26 May	13	7	Unoccluded	96	241.4	39.8
26 May	14	7	Unoccluded	96	246.6	38.9
26 May	15	7	Unoccluded	96	229.4	41.8
26 May	16	7	Unoccluded	88	218.9	40.2
26 May	17	7	Unoccluded	84	215.2	39.0
26 May	18	7	Unoccluded	84	214.6	39.1
26 May	19	7	Unoccluded	84	216.0	38.9
26 May	20	7	Unoccluded	84	223.4	37.6
26 May	21	7	Unoccluded	84	220.5	38.1
26 May	22	7	Unoccluded	80	214.3	37.3
26 May	23	7	Unoccluded	80	207.5	38.6
27 May	0	7	Unoccluded	80	213.0	37.6
27 May	1	7	Unoccluded	80	209.8	38.1
27 May	2	7	Unoccluded	80	208.1	38.4
27 May	3	7	Unoccluded	80	208.7	38.3
27 May	4	7	Unoccluded	80	207.8	38.5
27 May	5	7	Unoccluded	80	208.8	38.3
27 May	6	7	Unoccluded	80	208.8	38.3
27 May	7	7	Unoccluded	80	212.5	37.6
27 May	8	7	Unoccluded	80	210.2	38.1
27 May	9	7	Unoccluded	80	212.0	37.7
27 May	10	7	Unoccluded	82	218.5	37.5
27 May	11	7	Unoccluded	82	223.2	36.7
27 May	12	7	Unoccluded	86	231.2	37.2

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
27 May	13	7	Unoccluded	86	231.4	37.2
27 May	14	7	Unoccluded	86	234.7	36.6
27 May	15	7	Unoccluded	86	232.5	37.0
27 May	16	7	Unoccluded	86	233.2	36.9
27 May	17	7	Unoccluded	98	261.6	37.5
27 May	18	7	Unoccluded	98	263.4	37.2
27 May	19	7	Unoccluded	90	279.4	32.2
27 May	20	7	Unoccluded	90	280.5	32.1
27 May	21	7	Unoccluded	90	279.9	32.2
27 May	22	7	Unoccluded	90	277.5	32.4
27 May	23	7	Unoccluded	90	269.9	33.3
28 May	0	7	Unoccluded	90	274.3	32.8
28 May	1	7	Unoccluded	90	279.9	32.2
28 May	2	7	Unoccluded	90	282.5	31.9
28 May	3	7	Unoccluded	90	281.6	32.0
28 May	4	7	Unoccluded	90	283.7	31.7
28 May	5	7	Unoccluded	90	283.2	31.8
28 May	6	7	Unoccluded	90	297.3	30.3
28 May	7	7	Unoccluded	90	281.3	32.0
28 May	8	7	Unoccluded	90	285.4	31.5
28 May	9	7	Unoccluded	90	277.6	32.4
28 May	10	7	Unoccluded	90	279.6	32.2
28 May	11	7	Unoccluded	90	271.2	33.2
28 May	12	7	Unoccluded	90	273.3	32.9
28 May	13	7	Unoccluded	90	272.2	33.1
28 May	14	7	Unoccluded	86	270.2	31.8
28 May	15	7	Unoccluded	85	273.3	31.1
28 May	16	7	Unoccluded	85	267.2	31.8
28 May	17	7	Unoccluded	85	277.6	30.6
28 May	18	7	Unoccluded	85	290.9	29.2
28 May	19	7	Unoccluded	85	296.5	28.7
28 May	20	7	Unoccluded	85	288.8	29.4
28 May	21	7	Unoccluded	85	282.7	30.1
28 May	22	7	Unoccluded	85	210.5	40.4
28 May	23	7	Unoccluded	85	216.7	39.2
29 May	0	7	Unoccluded	85	214.8	39.6
29 May	1	7	Unoccluded	85	245.9	34.6
29 May	2	7	Unoccluded	85	312.0	27.2

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
29 May	3	7	Unoccluded	85	309.7	27.4
29 May	4	7	Unoccluded	85	318.9	26.7
29 May	5	7	Unoccluded	85	311.3	27.3
29 May	6	7	Unoccluded	85	330.8	25.7
29 May	7	7	Unoccluded	85	330.9	25.7
29 May	8	7	OccludedT	85	323.4	26.3
29 May	9	7	OccludedT	85	330.0	25.8
29 May	10	7	OccludedT	85	315.2	27.0
29 May	11	7	OccludedT	85	317.2	26.8
29 May	12	7	Occluded	85	310.4	27.4
29 May	13	7	Occluded	85	312.2	27.2
29 May	14	7	Occluded	75	294.9	25.4
29 May	15	7	Occluded	75	298.4	25.1
29 May	16	7	Occluded	75	295.4	25.4
29 May	17	7	Occluded	75	286.4	26.2
29 May	18	7	Occluded	75	299.0	25.1
29 May	19	7	Occluded	75	296.2	25.3
29 May	20	7	Occluded	75	301.9	24.8
29 May	21	7	Occluded	75	299.2	25.1
29 May	22	7	Occluded	75	282.6	26.5
29 May	23	7	Occluded	75	302.6	24.8
30 May	0	7	Occluded	75	263.9	28.4
30 May	1	7	Occluded	75	231.7	32.4
30 May	2	7	Occluded	75	226.5	33.1
30 May	3	7	Occluded	75	226.7	33.1
30 May	4	7	Occluded	75	230.7	32.5
30 May	5	7	Occluded	75	242.5	30.9
30 May	6	7	Occluded	75	275.8	27.2
30 May	7	7	Occluded	75	276.4	27.1
30 May	8	7	Occluded	75	277.4	27.0
30 May	9	7	Occluded	75	280.3	26.8
30 May	10	7	Occluded	75	309.9	24.2
30 May	11	7	Occluded	75	315.3	23.8
30 May	12	7	Occluded	75	316.4	23.7
30 May	13	7	Occluded	75	314.5	23.8
30 May	14	7	Occluded	75	285.1	26.3
30 May	15	7	Occluded	75	301.0	24.9
30 May	16	7	Occluded	75	314.1	23.9

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
30 May	17	7	Occluded	75	338.8	22.1
30 May	18	7	Occluded	75	355.6	21.1
30 May	19	7	Occluded	75	356.9	21.0
30 May	20	7	Occluded	75	358.0	20.9
30 May	21	7	Occluded	75	319.7	23.5
30 May	22	7	Occluded	75	263.6	28.5
30 May	23	7	Occluded	75	250.7	29.9
31 May	0	7	Occluded	75	253.9	29.5
31 May	1	7	Occluded	75	255.9	29.3
31 May	2	7	Occluded	75	292.0	25.7
31 May	3	7	Occluded	75	236.2	31.8
31 May	4	7	Occluded	75	201.1	37.3
31 May	5	7	Occluded	75	292.6	25.6
31 May	6	7	Occluded	75	297.4	25.2
31 May	7	7	Occluded	75	330.5	22.7
31 May	8	7	Occluded	75	330.5	22.7
31 May	9	7	Occluded	75	338.4	22.2
31 May	10	7	Occluded	75	336.3	22.3
31 May	11	7	Occluded	75	320.2	23.4
31 May	12	7	Occluded	75	327.0	22.9
31 May	13	7	Occluded	75	324.6	23.1
31 May	14	7	Occluded	75	291.8	25.7
31 May	15	7	Occluded	75	297.4	25.2
31 May	16	7	Occluded	75	296.1	25.3
31 May	17	7	Occluded	75	300.1	25.0
31 May	18	7	Occluded	75	298.8	25.1
31 May	19	7	Occluded	75	312.5	24.0
31 May	20	7	Occluded	75	330.1	22.7
31 May	21	7	Occluded	75	329.6	22.8
31 May	22	7	Occluded	75	296.1	25.3
31 May	23	7	Occluded	75	303.1	24.7
1 June	0	7	Occluded	75	297.0	25.3
1 June	1	7	Occluded	75	282.4	26.6
1 June	2	7	Occluded	75	291.8	25.7
1 June	3	7	Occluded	75	315.4	23.8
1 June	4	7	Occluded	75	326.8	22.9
1 June	5	7	Occluded	75	308.0	24.4
1 June	6	7	Occluded	75	307.8	24.4

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
1 June	7	7	Occluded	75	338.5	22.2
1 June	8	8	Unoccluded	75	334.1	22.4
1 June	9	8	Unoccluded	75	333.9	22.5
1 June	10	8	Unoccluded	75	333.4	22.5
1 June	11	8	Unoccluded	75	333.8	22.5
1 June	12	8	Unoccluded	75	337.0	22.3
1 June	13	8	Unoccluded	105	369.1	28.4
1 June	14	8	Unoccluded	105	342.2	30.7
1 June	15	8	Unoccluded	105	371.4	28.3
1 June	16	8	Unoccluded	105	372.1	28.2
1 June	17	8	Unoccluded	105	377.4	27.8
1 June	18	8	Unoccluded	120	405.5	29.6
1 June	19	8	Unoccluded	120	407.6	29.4
1 June	20	8	Unoccluded	120	394.1	30.4
1 June	21	8	Unoccluded	120	392.9	30.5
1 June	22	8	Unoccluded	200	377.6	53.0
1 June	23	8	Unoccluded	200	334.8	59.7
2 June	0	8	Unoccluded	200	331.2	60.4
2 June	1	8	Unoccluded	200	321.6	62.2
2 June	2	8	Unoccluded	200	302.9	66.0
2 June	3	8	Unoccluded	200	278.8	71.7
2 June	4	8	Unoccluded	200	279.6	71.5
2 June	5	8	Unoccluded	200	280.9	71.2
2 June	6	8	Unoccluded	200	283.6	70.5
2 June	7	8	Unoccluded	200	292.8	68.3
2 June	8	8	Unoccluded	200	310.4	64.4
2 June	9	8	Unoccluded	170	324.7	52.4
2 June	10	8	Unoccluded	170	322.8	52.7
2 June	11	8	Unoccluded	170	324.1	52.5
2 June	12	8	Unoccluded	170	321.0	53.0
2 June	13	8	Unoccluded	170	324.0	52.5
2 June	14	8	Unoccluded	170	347.5	48.9
2 June	15	8	Unoccluded	170	348.0	48.9
2 June	16	8	Unoccluded	170	323.4	52.6
2 June	17	8	Unoccluded	170	315.9	53.8
2 June	18	8	Unoccluded	170	322.0	52.8
2 June	19	8	Unoccluded	170	325.3	52.3
2 June	20	8	Unoccluded	75	320.9	23.4

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
2 June	21	8	Unoccluded	75	328.7	22.8
2 June	22	8	Unoccluded	75	320.3	23.4
2 June	23	8	Unoccluded	75	266.9	28.1
3 June	0	8	Unoccluded	180	259.6	69.3
3 June	1	8	Unoccluded	180	262.0	68.7
3 June	2	8	Unoccluded	180	265.8	67.7
3 June	3	8	Unoccluded	180	260.9	69.0
3 June	4	8	Unoccluded	180	261.4	68.9
3 June	5	8	Unoccluded	180	338.4	53.2
3 June	6	8	Unoccluded	75	179.1	41.9
3 June	7	8	Unoccluded	180	276.2	65.2
3 June	8	8	Unoccluded	75	265.2	28.3
3 June	9	8	Unoccluded	75	286.3	26.2
3 June	10	8	Unoccluded	75	319.4	23.5
3 June	11	8	Unoccluded	75	322.8	23.2
3 June	12	8	Unoccluded	75	328.0	22.9
3 June	13	8	Unoccluded	75	333.4	22.5
3 June	14	8	Unoccluded	75	334.0	22.5
3 June	15	8	Unoccluded	120	346.1	34.7
3 June	16	8	Unoccluded	120	342.7	35.0
3 June	17	8	Unoccluded	120	343.7	34.9
3 June	18	8	Unoccluded	120	343.6	34.9
3 June	19	8	Unoccluded	120	344.1	34.9
3 June	20	8	Unoccluded	120	342.5	35.0
3 June	21	8	Unoccluded	120	341.7	35.1
3 June	22	8	Unoccluded	120	322.5	37.2
3 June	23	8	Unoccluded	120	303.6	39.5
4 June	0	8	Unoccluded	120	304.9	39.4
4 June	1	8	Unoccluded	120	304.6	39.4
4 June	2	8	Unoccluded	120	310.6	38.6
4 June	3	8	Unoccluded	120	303.7	39.5
4 June	4	8	Unoccluded	120	304.6	39.4
4 June	5	8	Unoccluded	120	316.4	37.9
4 June	6	8	Unoccluded	120	322.0	37.3
4 June	7	8	Unoccluded	120	381.0	31.5
4 June	8	8	OccludedT	120	373.3	32.1
4 June	9	8	OccludedT	120	392.4	30.6
4 June	10	8	OccludedT	120	404.5	29.7

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
4 June	11	8	Occluded	120	346.4	34.6
4 June	12	8	Occluded	120	315.6	38.0
4 June	13	8	Occluded	120	313.5	38.3
4 June	14	8	Occluded	120	311.7	38.5
4 June	15	8	Occluded	120	318.5	37.7
4 June	16	8	Occluded	120	310.2	38.7
4 June	17	8	Occluded	120	314.9	38.1
4 June	18	8	Occluded	120	307.5	39.0
4 June	19	8	Occluded	140	347.0	40.3
4 June	20	8	Occluded	140	346.7	40.4
4 June	21	8	Occluded	140	347.2	40.3
4 June	22	8	Occluded	140	366.2	38.2
4 June	23	8	Occluded	240	345.7	69.4
5 June	0	8	Occluded	240	320.1	75.0
5 June	1	8	Occluded	240	319.8	75.0
5 June	2	8	Occluded	240	330.4	72.6
5 June	3	8	Occluded	240	320.3	74.9
5 June	4	8	Occluded	240	365.0	65.8
5 June	5	8	Occluded	240	333.4	72.0
5 June	6	8	Occluded	240	362.5	66.2
5 June	7	8	Occluded	240	331.4	72.4
5 June	8	8	Occluded	165	346.5	47.6
5 June	9	8	Occluded	120	345.7	34.7
5 June	10	8	Occluded	120	361.6	33.2
5 June	11	8	Occluded	160	417.0	38.4
5 June	12	8	Occluded	140	374.8	37.4
5 June	13	8	Occluded	140	378.6	37.0
5 June	14	8	Occluded	140	393.3	35.6
5 June	15	8	Occluded	140	393.8	35.6
5 June	16	8	Occluded	170	422.9	40.2
5 June	17	8	Occluded	170	400.6	42.4
5 June	18	8	Occluded	230	412.6	55.7
5 June	19	8	Occluded	230	413.3	55.6
5 June	20	8	Occluded	230	411.2	55.9
5 June	21	8	Occluded	230	417.1	55.1
5 June	22	8	Occluded	230	409.6	56.2
5 June	23	8	Occluded	230	369.0	62.3
6 June	0	8	Occluded	230	359.5	64.0

Appendix B continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
6 June	1	8	Occluded	230	341.1	67.4
6 June	2	8	Occluded	230	374.2	61.5
6 June	3	8	Occluded	230	347.4	66.2
6 June	4	8	Occluded	230	349.9	65.7
6 June	5	8	Occluded	230	354.8	64.8
6 June	6	8	Occluded	230	353.5	65.1
6 June	7	8	Occluded	125	364.4	34.3
6 June	8	8	Occluded	140	387.5	36.1
6 June	9	8	Occluded	140	386.9	36.2
6 June	10	8	Occluded	185	369.8	50.0
6 June	11	8	Occluded	230	416.1	55.3
6 June	12	8	Occluded	135	386.6	34.9
6 June	13	8	Occluded	135	403.6	33.4
6 June	14	8	Occluded	125	393.4	31.8
6 June	15	8	Occluded	125	395.9	31.6
6 June	16	8	Occluded	125	397.0	31.5
6 June	17	8	Occluded	170	388.0	43.8
6 June	18	8	Occluded	155	370.2	41.9
6 June	19	8	Occluded	180	371.3	48.5
6 June	20	8	Occluded	180	370.2	48.6
6 June	21	8	Occluded	180	368.3	48.9
6 June	22	8	Occluded	180	374.0	48.1
6 June	23	8	Occluded	180	363.0	49.6
7 June	0	8	Occluded	230	330.7	69.5
7 June	1	8	Occluded	230	338.1	68.0
7 June	2	8	Occluded	230	344.8	66.7
7 June	3	8	Occluded	230	343.7	66.9
7 June	4	8	Occluded	230	343.1	67.0
7 June	5	8	Occluded	230	362.3	63.5
7 June	6	8	Occluded	110	339.1	32.4
7 June	7	8	Occluded	110	347.5	31.7

Appendix C. Fork lengths and weights of juvenile steelhead released at Rock Creek during spring 2002.

Release Date	Release time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
4/29/02	2100	11	192.5	16.8	164-223	65.7	15.5	42.5-96.2
4/30/02	0900	6	190.3	12.4	178-212	58.7	13.3	44.5-82.0
5/01/02	2100	12	186.8	22.4	158-235	63.2	24.6	34.2-124.7
5/02/02	0900	15	192.3	12.9	167-214	62.7	13.9	34.4-84.8
5/03/02	2100	19	192.8	14.4	173-223	63.1	16.2	44.2-91.7
5/04/02	0900	18	181.7	13.6	157-205	54.2	12.8	32.0-75.0
5/05/02	2100	12	188.7	24.5	152-234	60.4	21.4	31.1-98.4
5/06/02	0900	12	190.9	24.6	158-257	65.7	28.3	35.1-139.6
5/07/02	2100	22	188.9	27.3	155-242	64.0	29.0	35.0-126.6
5/08/02	0900	16	190.1	18.7	167-231	64.2	19.0	43.8-109.1
5/09/02	2100	18	200.9	35.1	157-275	79.1	49.2	37.6-202.5
5/10/02	0900	18	190.0	19.8	158-242	61.4	19.7	34.9-110.6
5/11/02	2100	9	199.3	28.0	163-245	78.7	38.2	41.5-164.9
5/12/02	0900	10	179.6	18.7	143-200	52.3	15.9	24.1-72.1
5/13/02	2100	20	194.9	25.2	146-241	67.2	26.1	25.7-120.8
5/14/02	0900	24	192.6	17.4	161-240	62.5	17.2	31.7-112.4
5/15/02	2100	18	189.8	17.7	157-218	62.2	16.5	34.1-89.9
5/16/02	0900	18	181.9	13.1	160-207	57.2	13.6	38.1-95.4
5/17/02	2100	20	191.9	19.0	157-226	65.0	16.6	36.6-99.0
5/18/02	0900	19	185.3	18.4	159-224	58.6	18.2	34.0-109.6
5/19/02	2100	17	199.2	22.4	154-238	78.9	24.1	30.1-121.2
5/20/02	0900	20	187.3	16.1	154-212	61.9	17.5	32.5-90.0
5/21/02	2100	19	189.6	17.9	160-227	62.4	20.6	33.0-109.9
5/22/02	0900	19	186.9	20.0	154-227	63.3	23.1	33.6-114.3
5/23/02	2100	20	199.9	24.2	160-255	75.9	28.9	31.0-146.7
5/24/02	0900	18	188.0	11.9	169-210	62.7	13.1	35.8-80.7
5/25/02	2100	17	192.4	19.2	154-232	66.7	19.8	32.7-115.4
5/26/02	0900	20	185.0	17.5	161-217	57.0	15.1	36.0-90.0
5/27/02	2100	20	191.4	28.0	155-275	65.9	29.5	29.6-162.1
5/28/02	0900	18	192.0	19.4	146-224	63.8	17.6	27.4-90.3
5/29/02	2100	21	183.9	13.8	156-207	58.2	14.9	33.1-88.7
5/30/02	0900	20	189.2	29.8	143-260	65.4	34.9	28.7-156.5
6/03/02	2100	27	194.2	22.0	160-258	68.3	24.1	35.4-146.6
6/04/02	0900	29	183.6	14.4	153-223	56.6	15.9	27.1-91.4
Overall		602	189.9	20.4	143-275	63.6	22.6	24.1-202.5

Appendix D. Fork lengths and weights of juvenile steelhead released into the John Day Dam juvenile bypass during spring 2002.

Release Date	Release time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
4/30/02	2300	19	191	15.0	165-224	59.6	14.7	38.6-96.9
5/01/02	2300	20	181	24.4	120-215	57.7	19.5	25.4-94.7
5/02/02	2200	17	186	17.7	156-217	60.4	15.3	33.3-82.6
5/03/02	2200	19	192	18.8	155-216	63.2	19.5	31.6-87.4
5/04/02	2200	20	194	19.3	161-228	63.9	20.5	26.7-104.3
5/05/02	2300	17	194	30.9	156-260	68.5	37.2	33.3-175.8
5/06/02	2300	20	181	12.9	165-205	54.3	13.7	37.4-79.0
5/07/02	2300	16	196	21.5	154-230	68.0	24.1	31.2-120.9
5/08/02	2300	18	189	17.5	161-227	60.8	15.9	35.2-91.7
5/09/02	2200	18	183	18.5	160-246	55.5	24.6	32.8-145.2
5/12/02	2200	19	186	23.7	118-231	64.0	21.0	36.4-122.9
5/13/02	2200	20	184	13.8	160-214	54.4	13.8	33.1-95.7
5/14/02	2200	20	195	19.6	163-238	67.2	20.7	35.1-112.6
5/15/02	2300	18	188	19.0	162-225	60.9	19.6	36.6-105.0
5/16/02	2200	19	183	16.4	155-224	54.2	18.8	29.3-107.9
5/18/02	2200	10	198	20.8	166-238	69.0	22.9	26.3-109.3
5/20/02	2200	18	197	17.5	170-230	67.2	20.5	40.9-109.1
5/22/02	2200	20	197	21.0	163-244	68.5	20.8	34.5-112.4
5/23/02	2200	20	194	13.5	169-210	63.8	15.5	38.0-86.6
5/24/02	2200	18	193	22.4	164-253	62.4	23.5	34.1-132.7
5/25/02	2300	18	185	19.3	135-227	56.3	18.8	22.3-110.3
5/26/02	2300	19	184	18.2	152-221	57.1	18.2	29.8-104.2
5/28/02	2200	10	186	21.8	154-224	58.5	20.5	30.5-89.9
5/29/02	2200	20	192	21.4	155-234	60.7	20.9	29.1-108.0
5/30/02	2200	18	190	22.4	159-238	61.1	25.6	29.1-129.1
5/31/02	2200	19	180	17.9	160-220	49.7	16.8	34.8-97.0
6/03/02	2200	10	180	13.7	161-204	51.5	10.7	37.6-73.2
6/04/02	2200	10	181	18.7	155-206	52.9	18.2	29.6-87.8
6/05/02	2200	18	182	18.5	144-213	54.3	15.7	23.9-76.8
6/06/02	2200	20	183	14.6	161-220	55.2	13.8	37.7-81.8
Overall		528	188	19.6	118-260	60.1	20.1	22.3-175.8

Appendix E. Fork lengths and weights of juvenile steelhead released into the John Day Dam spillway during spring 2002.

Release Date	Release Time	N	Fork length (mm) Mean	SD	Range	Weight (g) Mean	SD	Range
4/30/02	1100	15	189	26.2	156-245	62.3	28.0	31.7-131.3
4/30/02	2300	18	190	19.4	161-245	64.6	24.9	33.1-147.6
5/01/02	2200	18	185	13.0	162-206	54.9	11.0	35.1-73.8
5/02/02	2200	19	192	17.5	156-216	62.6	15.1	38.3-86.6
5/03/02	2200	19	188	19.3	150-229	58.8	18.0	32.5-106.6
5/04/02	1100	17	189	17.3	156-217	59.3	16.3	30.8-91.9
5/04/02	2200	20	179	28.5	102-218	54.4	21.7	23.2-95.9
5/05/02	1000	16	180	16.1	154-206	52.7	13.9	29.6-74.5
5/05/02	2200	19	187	18.8	154-212	59.5	20.0	32.0-96.4
5/06/02	2300	20	183	18.8	156-236	56.0	18.5	32.4-114.0
5/07/02	2300	15	185	14.5	168-218	57.0	13.8	43.6-85.1
5/08/02	2200	19	190	20.4	164-255	63.0	23.5	43.8-150.8
5/09/02	2200	20	189	16.9	145-217	60.4	14.9	27.0-84.3
5/10/02	1000	19	183	18.9	150-231	56.2	21.3	27.1-127.1
5/12/02	2200	19	183	23.3	141-252	56.3	21.2	21.7-123.6
5/13/02	2200	19	191	22.8	156-236	65.7	26.0	33.8-123.3
5/14/02	2200	19	199	24.0	170-270	69.2	29.9	41.7-168.0
5/15/02	2200	20	192	20.0	162-229	66.4	20.5	41.1-106.1
5/16/02	2200	19	192	19.7	158-240	63.1	20.4	30.7-118.0
5/18/02	2200	10	189	23.5	165-233	59.3	27.1	23.6-110.5
5/20/02	1000	20	199	31.8	160-260	74.2	37.4	35.5-151.7
5/20/02	2200	20	200	25.3	151-254	73.2	30.3	27.4-156.3
5/21/02	1000	19	194	23.5	153-250	70.0	26.0	29.3-146.8
5/21/02	2200	13	187	15.1	157-207	59.7	14.0	34.4-77.6
5/22/02	2200	20	187	17.2	151-211	56.9	19.1	27.7-83.5
5/23/02	2300	20	198	25.1	152-241	70.6	26.1	26.5-122.5
5/24/02	2200	20	187	17.3	158-215	57.3	16.8	30.9-94.5
5/25/02	2300	16	183	20.1	158-211	56.9	18.6	32.6-86.9
5/26/02	1100	20	186	28.0	142-240	59.5	27.1	23.4-114.1
5/26/02	2300	20	192	19.3	145-221	69.0	25.5	37.7-144.3
5/29/02	2200	19	190	29.1	145-264	60.8	28.0	24.7-141.7
5/30/02	2200	19	179	15.3	149-208	49.7	15.0	27.2-91.1
5/31/02	2200	19	200	26.1	160-245	70.9	29.7	33.4-130.9
6/03/02	1100	10	183	13.8	155-200	55.4	14.0	29.2-74.3
6/03/02	2200	10	187	15.3	168-208	57.8	14.6	39.5-78.4
6/04/02	1100	18	175	16.1	145-203	47.6	14.2	24.2-79.1

Appendix E continued

Release Date	Release Time	N	Fork length (mm) Mean	SD	Range	Weight (g) Mean	SD	Range
6/04/02	2200	10	187	29.5	148-240	62.0	31.2	27.8-128.8
6/05/02	2200	19	188	23.1	155-251	59.6	24.6	31.2-135.9
6/06/02	1100	18	191	16.8	161-218	60.8	14.9	35.7-83.5
6/06/02	2200	19	183	15.7	157-224	54.9	16.6	31.4-103.0
Overall		709	188	21.5	102-270	61	21.6	21.7-168

Appendix F. Fork lengths and weights of juvenile steelhead released into the John Day Dam tailrace during spring 2002.

Release Date	Release Time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
4/30/02	1100	18	188	22.5	158-235	62.8	24.1	35.1-116.4
4/30/02	2300	19	193	20.5	161-224	67.3	20.6	36.9-110.4
5/01/02	2200	19	188	16.0	155-220	60.7	14.6	31.2-87.9
5/02/02	2200	19	182	18.7	134-209	54.6	14.9	22.7-81.7
5/03/02	2200	20	182	19.1	150-230	53.5	18.3	27.3-105.7
5/04/02	1100	19	187	21.4	150-228	58.6	21.1	27.9-105.2
5/04/02	2200	20	187	13.2	161-205	58.5	11.8	38.0-76.8
5/05/02	1000	20	194	19.2	150-230	64.6	20.0	30.3-110.5
5/05/02	2200	20	184	25.5	151-230	58.4	26.7	32.1-113.0
5/06/02	2300	20	189	21.0	164-229	60.5	21.2	35.2-108.4
5/07/02	2300	17	182	17.0	150-218	54.6	15.5	29.2-85.9
5/08/02	2200	18	190	20.7	162-230	64.1	23.6	33.5-117.5
5/09/02	2200	20	184	13.1	155-210	53.9	12.3	29.3-78.2
5/10/02	1000	17	185	21.2	157-241	58.1	21.0	37.4-120.8
5/12/02	2200	18	187	26.7	155-275	63.0	33.9	32.0-186.6
5/13/02	2200	20	192	19.7	148-231	64.9	22.6	29.8-128.2
5/14/02	2200	20	192	20.1	160-226	63.8	22.0	34.3-109.5
5/15/02	2200	20	185	19.7	148-217	56.4	17.2	26.4-89.1
5/16/02	2200	20	191	16.4	159-223	63.6	18.2	33.8-98.5
5/17/02	2200	19	193	24.9	148-254	67.1	35.7	27.7-181.3
5/18/02	1100	19	189	26.8	117-222	62.2	18.0	29.3-93.3
5/18/02	2200	20	192	14.3	163-220	65.3	16.4	36.4-98.3
5/19/02	1000	19	191	17.2	160-225	63.8	17.1	37.3-93.6
5/20/02	1000	19	185	23.2	137-226	57.0	21.5	21.7-100.1
5/20/02	2200	17	182	15.5	160-218	53.6	20.5	21.5-105.0
5/21/02	1000	20	201	20.6	158-225	75.1	22.0	35.1-110.6
5/21/02	2200	19	194	18.8	159-226	67.7	21.1	33.6-111.2
5/22/02	2200	19	197	27.3	151-250	73.4	30.4	26.6-136.2
5/23/02	2300	20	189	23.0	154-247	67.1	27.4	30.3-144.2
5/24/02	2200	15	197	21.0	161-239	65.0	21.0	36.1-107.4
5/25/02	2300	16	187	24.8	151-235	59.0	26.3	28.0-107.5
5/26/02	1100	20	185	19.1	158-225	57.1	19.1	33.9-92.4
5/26/02	2300	19	182	16.5	154-222	52.5	18.0	27.2-101.6
5/27/02	1100	11	184	13.5	158-196	59.4	11.3	36.6-72.2
5/27/02	2200	20	182	19.1	153-221	54.1	18.3	31.1-99.7
5/28/02	2200	18	194	21.2	160-234	67.6	21.0	38.4-109.9

Appendix F continued

Release Date	Release Time	N	Fork length (mm) Mean	SD	Range	Weight (g) Mean	SD	Range
5/29/02	1100	19	196	21.1	165-240	68.3	23.2	41.1-129.1
5/29/02	2200	20	196	27.9	150-258	68.8	32.0	28.0-159.1
5/30/02	2200	19	197	23.6	161-240	67.9	23.8	35.2-107.1
5/31/02	2200	19	184	20.2	159-228	54.8	19.2	30.9-99.9
6/03/02	1100	20	181	19.8	138-227	51.7	15.6	21.3-91.8
6/03/02	2200	20	185	20.2	160-222	56.9	21.2	32.9-107.8
6/04/02	1100	20	194	29.2	149-264	69.1	37.6	26.8-181.2
6/04/02	2200	18	191	22.4	153-230	63.5	22.3	30.8-101.8
6/05/02	2200	19	185	13.8	162-216	57.9	14.4	35.3-96.8
6/06/02	1100	20	189	18.3	162-230	61.2	19.9	33.5-109.5
6/06/02	2200	17	177	14.5	153-210	50.4	14.3	31.8-85.1
Overall		885	189	20.2	117-275	61.4	21.0	21.0-187.0

Appendix G. Fork lengths and weights of yearling Chinook salmon released at Rock Creek during spring 2002.

Release Date	Release time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
4/29/02	2100	46	150.2	10.3	134-179	33.7	7.3	23.8-57.5
4/30/02	0900	45	151.3	15.4	128-191	34.9	11.3	23.1-68.5
5/01/02	2100	48	150.7	12.2	125-179	34.9	9.3	19.8-61.9
5/02/02	0900	44	149.3	12.4	133-194	33.6	9.2	22.6-74.5
5/03/02	2100	47	146.7	13.6	116-170	33.0	7.6	15.8-51.8
5/04/02	0900	54	151.0	10.9	129-181	33.8	7.9	22.3-58.7
5/05/02	2100	51	150.5	10.9	132-180	33.7	8.1	22.4-57.9
5/06/02	0900	44	147.8	11.8	124-188	33.9	9.3	20.9-71.4
5/07/02	2100	46	147.7	11.5	124-175	31.5	7.5	17.6-54.8
5/08/02	0900	48	152.0	12.6	129-196	34.2	10.0	19.2-76.2
5/09/02	2100	49	146.4	11.6	130-176	31.5	8.1	22.0-53.7
5/10/02	0900	48	148.8	13.2	127-185	33.6	9.0	19.1-62.7
5/11/02	2100	50	147.8	14.7	120-182	34.1	10.1	19.2-57.6
5/12/02	0900	45	146.5	14.0	126-186	29.5	9.7	17.8-60.0
5/13/02	2100	55	143.8	13.0	121-177	28.7	8.2	16.5-50.7
5/14/02	0900	47	145.6	12.1	124-186	30.7	8.8	18.3-65.1
5/15/02	2100	49	140.1	15.0	120-186	28.8	10.4	16.0-65.5
5/16/02	0900	49	143.6	13.8	120-176	30.0	8.8	16.6-54.6
5/17/02	2100	46	144.9	15.2	124-191	30.4	10.9	18.2-67.6
5/18/02	0900	48	142.3	15.6	120-205	28.5	11.6	17.6-82.8
5/19/02	2100	46	141.8	10.4	120-175	27.5	6.7	17.3-50.9
5/20/02	0900	54	141.4	12.9	125-191	25.7	8.6	17.2-65.8
5/21/02	2100	53	148.5	17.8	122-204	31.3	12.8	17.3-81.0
5/22/02	0900	49	149.0	17.5	120-190	33.1	12.7	18.3-72.6
5/23/02	2100	52	149.9	19.0	123-192	35.0	12.7	19.0-66.4
5/24/02	0900	52	146.5	17.2	124-187	33.2	11.7	19.8-65.4
5/25/02	2100	49	153.1	18.3	130-205	37.6	15.0	21.6-85.4
5/26/02	0900	49	148.6	16.4	122-196	33.6	11.8	19.1-72.3
5/27/02	2100	52	147.6	16.2	121-185	31.0	10.6	17.3-61.8
5/28/02	0900	53	156.7	16.5	126-190	38.6	11.7	18.4-64.4
5/29/02	2100	49	155.1	18.2	124-200	36.8	12.5	19.1-65.3
5/30/02	0900	52	157.7	18.1	128-201	39.8	14.0	18.0-82.9
Overall		1569	148.3	15.0	116-205	32.7	10.7	15.8-85.4

Appendix H. Fork lengths and weights of yearling Chinook salmon released into the John Day Dam juvenile bypass during spring 2002.

Release Date	Release time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
4/30/02	2300	20	155	9.6	134-176	36.9	7.8	23.5-58.8
5/01/02	2300	18	150	13.5	133-180	34.8	9.8	23.8-56.8
5/02/02	2200	19	150	15.0	123-190	34.5	11.2	23.3-69.7
5/03/02	2200	20	149	12.6	119-176	33.6	8.6	16.0-54.3
5/04/02	2200	20	142	8.6	127-167	29.0	5.5	20.6-44.2
5/05/02	2200	20	151	8.8	139-169	34.9	7.2	25.4-52.0
5/06/02	2300	20	150	11.3	133-177	33.1	7.6	21.9-48.8
5/08/02	2300	20	145	11.6	125-168	29.0	6.7	19.2-43.6
5/09/02	2200	19	149	15.1	132-199	32.7	12.3	22.7-78.3
5/10/02	2100	20	145	15.5	126-183	30.7	10.6	19.5-60.1
5/11/02	2300	20	143	13.9	120-174	27.1	7.7	16.8-43.7
5/12/02	2200	20	147	13.0	130-179	31.9	8.6	21.3-55.6
5/13/02	2200	20	140	9.8	119-170	29.6	7.4	16.1-48.9
5/14/02	2200	20	141	12.7	122-178	28.6	8.3	20.0-58.1
5/15/02	2300	16	151	20.8	122-201	35.0	15.9	17.3-76.9
5/16/02	2200	19	144	12.1	127-172	29.6	9.5	18.9-51.9
5/17/02	2200	19	143	13.3	126-184	30.5	9.5	18.4-57.8
5/18/02	2200	17	149	17.3	131-198	32.2	14.4	20.8-77.1
5/19/02	2200	19	149	14.6	130-189	33.9	10.9	23.3-63.5
5/20/02	2200	20	147	18.8	124-186	31.5	13.3	19.1-65.2
5/21/02	2200	19	145	17.3	123-186	30.8	12.5	17.0-61.5
5/22/02	2200	15	141	14.5	120-170	28.5	8.6	19.6-49.0
5/23/02	2200	14	147	15.3	124-182	32.5	10.1	21.9-57.4
5/24/02	2200	18	153	21.7	127-195	36.7	15.9	21.3-69.1
5/25/02	2300	19	145	15.5	129-184	30.3	10.3	19.9-56.6
5/26/02	2300	19	151	17.0	125-181	33.7	11.6	19.5-55.9
5/27/02	2200	18	152	17.0	128-191	33.1	11.8	18.7-61.5
5/28/02	2200	19	165	20.2	126-200	45.1	14.9	22.1-73.9
5/29/02	2200	18	148	17.9	130-195	35.9	12.3	22.7-68.5
5/30/02	2200	20	146	17.4	128-193	28.8	11.5	20.1-64.4
5/31/02	2200	18	151	19.3	132-190	35.2	13.0	23.8-60.7
Overall		583	148	15.6	119-201	32.5	11.0	16-78.3

Appendix I. Fork lengths and weights of yearling Chinook salmon released into the John Day Dam tailrace during spring 2002.

Release Date	Release time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
4/30/02	1100	18	148	10.8	130-165	31.2	6.4	20.4-41.2
4/30/02	2300	20	154	11.3	133-182	35.8	8.5	22.0-61.3
5/01/02	2200	19	149	12.0	132-172	33.1	8.1	20.9-51.9
5/02/02	1100	14	143	11.1	127-165	30.2	6.8	19.4-45.7
5/02/02	2200	19	153	14.1	136-186	35.6	10.3	25.1-65.4
5/03/02	2200	19	146	12.8	121-165	31.3	7.9	15.7-44.7
5/04/02	2200	19	146	7.1	132-160	29.3	4.4	18.3-38.5
5/04/02	1100	19	147	9.7	125-163	31.8	5.9	20.4-43.0
5/05/02	2200	20	149	10.4	132-178	33.9	7.8	22.2-56.5
5/06/02	1100	24	150	12.4	132-178	34.0	8.7	23.2-56.7
5/06/02	2300	20	156	13.8	133-191	35.8	11.3	24.2-70.0
5/08/02	1100	21	148	12.2	127-176	32.1	8.6	18.7-52.8
5/08/02	2200	19	152	16.5	127-185	34.3	11.0	18.6-59.0
5/09/02	2200	18	146	7.3	128-160	30.1	4.2	20.5-37.3
5/10/02	1000	20	145	12.0	124-178	30.2	8.7	18.0-53.9
5/10/02	2100	19	142	12.1	121-175	28.9	8.4	17.3-52.1
5/11/02	2300	18	150	19.9	128-204	32.7	16.3	18.7-77.8
5/12/02	1100	20	138	13.1	126-189	25.7	8.9	18.1-60.6
5/12/02	2200	20	145	11.6	127-172	30.6	7.6	20.3-48.5
5/13/02	2200	20	143	10.0	125-168	29.5	4.8	18.6-40.2
5/14/02	1100	16	144	14.1	122-172	27.8	8.7	17.0-48.0
5/14/02	2200	20	139	9.4	129-172	28.0	6.1	21.3-48.1
5/15/02	2200	18	146	13.8	126-176	30.5	8.5	19.1-49.8
5/16/02	1100	18	150	19.3	123-184	34.4	14.0	17.9-64.6
5/16/02	2200	19	143	13.2	123-177	28.3	7.9	18.1-50.5
5/17/02	2200	20	137	10.5	124-166	27.5	6.6	20.2-50.6
5/18/02	1100	19	144	15.9	126-184	29.3	11.0	18.7-67.6
5/18/02	2200	20	158	22.2	132-203	39.5	18.4	19.2-78.8
5/19/02	2200	19	147	14.6	125-179	31.8	9.6	17.5-53.8
5/20/02	1000	20	140	12.3	127-177	25.3	9.4	19.1-55.9
5/20/02	2200	20	156	20.6	128-189	38.3	16.5	20.5-69.9
5/21/02	2200	19	152	15.0	127-184	34.8	10.2	20.6-59.2
5/22/02	1100	19	163	20.5	126-190	43.2	15.7	19.7-68.8
5/22/02	2200	19	139	14.2	120-165	28.0	8.4	16.1-46.0
5/23/02	2300	16	154	15.2	126-182	36.7	9.6	23.4-54.7
5/24/02	1100	17	155	20.2	127-186	39.3	12.9	22.3-61.6

Appendix I continued

Release Date	Release Time	N	Fork length (mm) Mean	SD	Range	Weight (g) Mean	SD	Range
5/24/02	2200	15	152	18.5	120-186	35.5	13.5	17.4-63.0
5/25/02	2300	17	148	18.5	122-195	31.6	13.3	19.7-70.2
5/26/02	1100	18	147	12.7	130-183	28.0	8.0	21.0-54.3
5/26/02	2300	20	153	13.3	131-178	35.1	10.0	20.2-59.7
5/27/02	2200	20	160	19.0	127-187	38.6	13.6	19.8-61.3
5/28/02	1100	20	152	11.7	134-179	34.4	10.1	23.7-60.6
5/28/02	2200	20	164	27.6	127-215	47.3	23.8	21.6-107.3
5/29/02	2200	18	151	15.6	134-189	37.1	11.5	25.0-68.7
5/30/02	1100	19	154	16.1	128-179	36.4	10.6	20.9-56.4
5/30/02	2200	20	155	19.6	126-194	35.5	14.5	19.1-71.8
5/31/02	2200	19	143	10.1	133-172	29.4	6.4	23.4-47.0
Overall		891	148	14.1	120-215	32.6	9.9	15.7-107.3

Appendix J. Passage route of yearling Chinook salmon and juvenile wild steelhead detected at main turbine units 1 through 3 at The Dalles Dam by block, treatment, diel, and date, spring 2002. Day=0530 to 2059 hours, Night=2100 to 0529 hours.

Species	Block	Treatment	Diel	Date	Turbines	Sluiceway	Spillway
CH1	3	Occluded	Day	5 May	0	1	0
CH1	3	Occluded	Day	6 May	2	2	9
CH1	3	Occluded	Day	7 May	2	2	6
CH1	3	Occluded	Day	8 May	0	4	3
CH1	3	Occluded	Night	5 May	1	2	0
CH1	3	Occluded	Night	6 May	3	5	1
CH1	3	Occluded	Night	7 May	3	8	2
CH1	3	Occluded	Night	8 May	0	5	0
CH1	3	Unoccluded	Day	2 May	13	2	5
CH1	3	Unoccluded	Day	3 May	5	6	0
CH1	3	Unoccluded	Day	4 May	10	9	7
CH1	3	Unoccluded	Day	5 May	5	0	1
CH1	3	Unoccluded	Night	2 May	0	3	0
CH1	3	Unoccluded	Night	3 May	0	3	1
CH1	3	Unoccluded	Night	4 May	1	1	0
CH1	3	Unoccluded	Night	5 May	3	3	0
CH1	4	Occluded	Day	8 May	0	0	1
CH1	4	Occluded	Day	9 May	6	4	3
CH1	4	Occluded	Day	10 May	0	3	1
CH1	4	Occluded	Day	11 May	1	1	0
CH1	4	Occluded	Night	9 May	1	3	3
CH1	4	Occluded	Night	10 May	1	3	0
CH1	4	Occluded	Night	11 May	1	3	0
CH1	4	Unoccluded	Day	11 May	6	4	0
CH1	4	Unoccluded	Day	12 May	8	5	2
CH1	4	Unoccluded	Day	13 May	30	1	3
CH1	4	Unoccluded	Day	14 May	0	1	1
CH1	4	Unoccluded	Night	12 May	3	3	0
CH1	4	Unoccluded	Night	13 May	1	4	1
CH1	4	Unoccluded	Night	14 May	3	3	0
CH1	5	Occluded	Day	14 May	0	1	2
CH1	5	Occluded	Day	15 May	3	5	2
CH1	5	Occluded	Day	16 May	1	2	1

Appendix J continued

Species	Block	Treatment	Diel	Date	Turbines	Sluiceway	Spillway
CH1	5	Occluded	Day	17 May	0	1	1
CH1	5	Occluded	Night	15 May	2	3	1
CH1	5	Occluded	Night	16 May	1	5	1
CH1	5	Occluded	Night	17 May	0	2	1
CH1	5	Unoccluded	Day	17 May	10	7	0
CH1	5	Unoccluded	Day	18 May	11	2	1
CH1	5	Unoccluded	Day	19 May	5	7	1
CH1	5	Unoccluded	Night	17 May	1	3	1
CH1	5	Unoccluded	Night	18 May	1	4	0
CH1	5	Unoccluded	Night	19 May	3	4	0
CH1	6	Occluded	Day	23 May	1	4	1
CH1	6	Occluded	Day	24 May	0	1	1
CH1	6	Occluded	Day	25 May	1	4	5
CH1	6	Occluded	Day	26 May	1	1	0
CH1	6	Occluded	Night	24 May	0	1	1
CH1	6	Occluded	Night	25 May	0	4	1
CH1	6	Occluded	Night	26 May	0	1	0
CH1	6	Unoccluded	Day	20 May	0	1	0
CH1	6	Unoccluded	Day	21 May	3	9	0
CH1	6	Unoccluded	Day	22 May	16	3	0
CH1	6	Unoccluded	Day	23 May	0	2	0
CH1	6	Unoccluded	Night	21 May	0	3	2
CH1	6	Unoccluded	Night	22 May	1	4	0
CH1	6	Unoccluded	Night	23 May	3	0	0
CH1	7	Occluded	Day	29 May	2	0	4
CH1	7	Occluded	Day	30 May	1	2	0
CH1	7	Occluded	Day	31 May	4	10	10
CH1	7	Occluded	Day	1 June	0	1	0
CH1	7	Occluded	Night	29 May	1	2	0
CH1	7	Occluded	Night	30 May	1	1	0
CH1	7	Occluded	Night	31 May	0	1	0
CH1	7	Unoccluded	Day	26 May	1	1	1
CH1	7	Unoccluded	Day	27 May	14	9	9
CH1	7	Unoccluded	Day	28 May	8	3	2
CH1	7	Unoccluded	Day	29 May	0	1	1

Appendix J continued

Species	Block	Treatment	Diel	Date	Turbines	Sluiceway	Spillway
CH1	7	Unoccluded	Night	26 May	1	0	0
CH1	7	Unoccluded	Night	27 May	1	3	0
CH1	7	Unoccluded	Night	28 May	2	1	0
CH1	7	Unoccluded	Night	29 May	1	6	0
STH	3	Occluded	Day	5 May	0	4	7
STH	3	Occluded	Day	6 May	2	14	10
STH	3	Occluded	Day	7 May	2	9	9
STH	3	Occluded	Night	5 May	0	1	2
STH	3	Occluded	Night	6 May	1	3	0
STH	3	Occluded	Night	7 May	3	1	1
STH	3	Unoccluded	Day	2 May	2	13	6
STH	3	Unoccluded	Day	3 May	1	9	4
STH	3	Unoccluded	Day	4 May	3	17	6
STH	3	Unoccluded	Day	5 May	1	1	0
STH	3	Unoccluded	Night	2 May	0	1	1
STH	3	Unoccluded	Night	3 May	0	4	3
STH	3	Unoccluded	Night	4 May	2	4	0
STH	3	Unoccluded	Night	5 May	1	6	2
STH	4	Occluded	Day	8 May	0	3	2
STH	4	Occluded	Day	9 May	2	13	5
STH	4	Occluded	Day	10 May	0	3	3
STH	4	Occluded	Night	9 May	1	2	6
STH	4	Occluded	Night	10 May	0	1	1
STH	4	Occluded	Night	11 May	0	2	0
STH	4	Unoccluded	Day	11 May	0	3	1
STH	4	Unoccluded	Day	12 May	0	3	1
STH	4	Unoccluded	Day	13 May	3	9	12
STH	4	Unoccluded	Day	14 May	0	1	0
STH	4	Unoccluded	Night	13 May	0	0	1
STH	5	Occluded	Day	14 May	0	10	7
STH	5	Occluded	Day	15 May	0	5	6
STH	5	Occluded	Day	16 May	1	1	1
STH	5	Occluded	Day	17 May	0	0	1
STH	5	Occluded	Night	14 May	0	0	1
STH	5	Occluded	Night	15 May	1	3	2

Appendix J continued

Species	Block	Treatment	Diel	Date	Turbines	Sluiceway	Spillway
STH	5	Occluded	Night	16 May	0	2	1
STH	5	Occluded	Night	17 May	1	0	0
STH	5	Unoccluded	Day	17 May	0	3	9
STH	5	Unoccluded	Day	18 May	0	3	3
STH	5	Unoccluded	Day	19 May	1	5	0
STH	5	Unoccluded	Night	17 May	0	0	2
STH	5	Unoccluded	Night	18 May	0	2	1
STH	5	Unoccluded	Night	19 May	1	2	1
STH	6	Occluded	Day	23 May	0	1	1
STH	6	Occluded	Day	24 May	0	4	1
STH	6	Occluded	Day	25 May	1	2	1
STH	6	Occluded	Night	23 May	0	1	0
STH	6	Occluded	Night	25 May	0	0	1
STH	6	Occluded	Night	26 May	0	1	0
STH	6	Unoccluded	Day	20 May	0	1	0
STH	6	Unoccluded	Day	21 May	0	20	6
STH	6	Unoccluded	Day	22 May	1	8	2
STH	6	Unoccluded	Day	23 May	1	0	0
STH	6	Unoccluded	Night	21 May	1	4	1
STH	6	Unoccluded	Night	22 May	0	3	0
STH	7	Occluded	Day	29 May	1	2	2
STH	7	Occluded	Day	30 May	2	8	3
STH	7	Occluded	Day	31 May	0	6	10
STH	7	Occluded	Night	29 May	1	4	3
STH	7	Occluded	Night	30 May	1	2	0
STH	7	Occluded	Night	31 May	0	3	1
STH	7	Unoccluded	Day	26 May	1	2	0
STH	7	Unoccluded	Day	27 May	0	10	4
STH	7	Unoccluded	Day	28 May	0	12	0
STH	7	Unoccluded	Night	27 May	0	2	0
STH	7	Unoccluded	Night	29 May	1	1	0
STH	8	Occluded	Day	4 June	0	1	0
STH	8	Occluded	Day	5 June	0	3	4
STH	8	Occluded	Day	6 June	1	4	4
STH	8	Occluded	Day	7 June	0	1	0

Appendix J continued

Species	Block	Treatment	Diel	Date	Turbines	Sluiceway	Spillway
STH	8	Occluded	Night	4 June	1	1	0
STH	8	Occluded	Night	5 June	0	1	0
STH	8	Occluded	Night	6 June	1	3	2
STH	8	Occluded	Night	7 June	3	1	0
STH	8	Unoccluded	Day	1 June	1	5	2
STH	8	Unoccluded	Day	2 June	0	1	0
STH	8	Unoccluded	Day	3 June	0	2	1
STH	8	Unoccluded	Night	1 June	1	0	1

Appendix K. Estimates of wild juvenile steelhead fish passage efficiency (FPE) for those detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded treatments at The Dalles Dam, 02 May through 01 June 2002. Day is defined as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed
Block	FPE	N	Odds	FPE	N	Odds	Odds Ratio
3	93.0	57	13.286	88.9	63	6.875	0.603
4	96.7	30	29.000	90.9	33	9.638	0.332
5	96.9	32	31.258	100.0	23	-	-
6	90.9	11	10.000	100.0	37	-	-
7	93.9	33	15.500	93.9	29	28.412	1.833
8	94.4	18	17.000	92.3	12	11.048	0.650
Overall odds ratio adjusted for Blocks 3-8 (95%LRCI) 0.812(0.351-2.081)							
Test HO: odds ratio=1 (no treatment effect), P>0.74.							

Night							
	Occluded			Unoccluded			Observed
Block	FPE	N	Odds	FPE	N	Odds	Odds Ratio
3	66.7	12	2.000	87.5	24	7.000	3.500
4	92.3	13	12.000	100.0	1	-	-
5	81.9	11	4.525	88.9	9	8.000	1.768
6	100.0	3	-	88.9	9	8.000	-
7	86.7	15	6.519	100	3	-	-
8	61.6	13	1.604	50	2	1.000	0.623
Overall odds ratio adjusted for Blocks 3-8 (95%LRCI) 2.050(0.628-7.173)							
Test HO: odds ratio=1 (no treatment effect), P>0.24.							

Appendix L. Estimates of wild juvenile steelhead spill passage efficiency (SPE) for those detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded treatments at The Dalles Dam, 02 May through 01 June 2002. Day is defined as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed
Block	SPE	N	Odds	SPE	N	Odds	Odds Ratio
3	45.6	57	0.838	25.4	63	0.400	0.477
4	33.3	30	0.500	42.4	33	0.736	1.472
5	46.9	32	0.743	52.2	23	1.091	1.468
6	27.3	11	0.375	21.6	37	0.276	0.736
7	45.5	33	0.833	13.8	29	0.160	0.192
8	44.4	18	0.800	25.0	12	0.333	0.416
Overall odds ratio adjusted for Blocks 3-8 (95%LRCI)						0.590(0.380-0.913)	
Test HO: odds ratio=1 (no treatment effect), P<0.02.							

Night							
	Occluded			Unoccluded			Observed
Block	SPE	N	Odds	SPE	N	Odds	Odds Ratio
3	25.0	12	0.333	25.0	24	0.333	1.000
4	53.8	13	1.167	100.0	1	-	-
5	36.4	11	0.572	44.4	9	0.800	1.399
6	33.3	3	0.500	11.1	9	0.125	0.250
7	26.7	15	0.364	0.0	3	0.000	0.000
8	15.4	13	0.182	50.0	2	1.000	5.494
Overall odds ratio adjusted for Blocks 3-8 (95%LRCI)						1.069(0.397-2.909)	
Test HO: odds ratio=1 (no treatment effect), P>0.89.							

Appendix M. Estimates of wild juvenile steelhead sluiceway passage efficiency (SLPE) for those detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded treatments at The Dalles Dam, 02 May through 01 June 2002. Day is defined as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed
Block	SLPE	N	Odds	SLPE	N	Odds	Odds Ratio
3	47.4	57	0.901	63.5	63	1.739	1.930
4	63.3	30	1.727	48.5	33	0.942	0.545
5	50.0	32	1.000	47.8	23	0.917	0.917
6	63.6	11	1.750	78.4	37	3.625	2.071
7	48.5	33	0.941	82.8	29	4.814	5.116
8	50.0	18	1.000	66.7	12	2.003	2.003
Overall odds ratio adjusted for Blocks 3-8 (95%LRCI)						1.589(1.040-2.432)	
Test HO: odds ratio=1 (no treatment effect), P<0.04.							

Night							
	Occluded			Unoccluded			Observed
Block	SLPE	N	Odds	SLPE	N	Odds	Odds Ratio
3	41.7	12	0.714	62.5	24	1.666	2.333
4	38.5	13	0.625	0.0	1	0.000	0.000
5	45.5	11	0.835	44.4	9	0.800	0.958
6	66.7	3	2.000	77.8	9	3.500	1.750
7	60.0	15	1.500	100.0	3	-	-
8	46.2	13	0.859	0.0	2	0.000	0.000
Overall odds ratio adjusted for Blocks 3-8 (95%LRCI)						1.426(0.583-3.516)	
Test HO: odds ratio=1 (no treatment effect), P>0.43.							

Appendix N. Estimates of yearling Chinook salmon fish passage efficiency (FPE) for those detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded treatments at The Dalles Dam, 02 May through 01 June 2002. Day is defined as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed
Block	FPE	N	Odds	FPE	N	Odds	Odds Ratio
3	87.1	31	6.750	48.4	64	0.938	0.139
4	65.0	20	1.857	28.0	61	0.385	0.207
5	78.9	19	3.750	41.0	44	0.695	0.185
6	85.0	20	5.666	44.1	34	0.789	0.139
7	81.8	33	4.494	54.0	50	1.174	0.261
Overall odds ratio adjusted for Blocks 3-7 (95%LRCI)					0.186(0.109-0.291)		
Test HO: odds ratio=1 (no treatment effect), P<0.0001.							

Night							
	Occluded			Unoccluded			Observed
Block	FPE	N	Odds	FPE	N	Odds	Odds Ratio
3	76.7	30	3.286	73.3	15	2.750	0.837
4	80.0	15	4.000	61.3	18	1.584	0.396
5	86.7	15	6.500	75.0	16	3.000	0.462
6	100.0	8	-	69.2	13	2.250	-
7	66.7	6	2.000	66.7	15	2.000	1.000
Overall odds ratio adjusted for Blocks 3-7 (95%LRCI)					0.510(0.227-1.109)		
Test HO: odds ratio=1 (no treatment effect), P>0.09.							

Appendix O. Estimates of yearling Chinook salmon spill passage efficiency (SPE) for those detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded treatments at The Dalles Dam, 02 May through 01 June 2002. Day is defined as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed Odds Ratio
Block	SPE	N	Odds	SPE	N	Odds	
3	58.1	31	1.385	20.3	64	0.254	0.183
4	25.0	20	0.333	9.8	61	0.109	0.327
5	31.6	19	0.462	4.6	44	0.048	0.104
6	35.0	20	0.538	0.0	34	0.000	0.000
7	42.4	33	0.736	26.0	50	0.351	0.477
Overall odds ratio adjusted for Blocks 3-7 (95%LRCI)						0.221(0.095-0.497)	
Test HO: odds ratio=1 (no treatment effect), P<0.0002.							

Night							
	Occluded			Unoccluded			Observed Odds Ratio
Block	SPE	N	Odds	SPE	N	Odds	
3	10.0	30	0.111	6.7	15	0.071	0.643
4	20.0	15	0.250	5.6	18	0.059	0.236
5	20.0	15	0.250	6.3	16	0.067	0.267
6	25.0	8	0.333	15.4	13	0.182	0.546
7	0.0	6	0.000	0.0	15	0.000	-
Overall odds ratio adjusted for Blocks 3-7 (95%LRCI)						0.380(0.119-1.208)	
Test HO: odds ratio=1 (no treatment effect), P>0.10.							

Appendix P. Estimates of yearling Chinook salmon sluiceway passage efficiency (SLPE) for those detected within 10 m of main turbine unit 1 through main turbine unit 3 during occluded and unoccluded treatments at The Dalles Dam, 02 May through 01 June 2002. Day is defined as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed
Block	SLPE	N	Odds	SLPE	N	Odds	Odds Ratio
3	29.0	31	0.409	28.1	64	0.391	0.956
4	40.0	20	0.667	18.0	61	0.219	0.328
5	47.4	19	0.900	36.4	44	0.572	0.635
6	50.0	20	1.000	44.1	34	0.789	0.789
7	39.4	33	0.650	28.0	50	0.388	0.966
Overall odds ratio adjusted for Blocks 3-7 (95%LRCI)					0.642(0.405-1.018)		
Test HO: odds ratio=1 (no treatment effect), P>0.06.							

Night							
	Occluded			Unoccluded			Observed
Block	SLPE	N	Odds	SLPE	N	Odds	Odds Ratio
3	66.7	30	2.000	66.7	15	2.000	1.000
4	60.0	15	1.500	55.7	18	1.257	0.838
5	66.7	15	2.000	68.8	16	2.200	1.100
6	75.0	8	3.000	53.8	13	1.167	0.467
7	66.7	6	2.000	66.7	15	2.003	1.001
Overall odds ratio adjusted for Blocks 3-7 (95%LRCI)					0.856(0.426-1.710)		
Test HO: odds ratio=1 (no treatment effect), P>0.66.							

Appendix Q. Summer treatment blocks for evaluating SGIDs at The Dalles Dam in 2002. Three-day treatments of both an occluded and an unoccluded condition comprise each six-day block.

Block	Date	Treatment
1	1-Jun	Unoccluded
1	2-Jun	Unoccluded
1	3-Jun	Unoccluded
1	4-Jun	Occluded
1	5-Jun	Occluded
1	6-Jun	Occluded
2	7-Jun	Occluded
2	8-Jun	Occluded
2	9-Jun	Occluded
2	10-Jun	Unoccluded
2	11-Jun	Unoccluded
2	12-Jun	Unoccluded
3	13-Jun	Occluded
3	14-Jun	Occluded
3	15-Jun	Occluded
3	16-Jun	Unoccluded
3	17-Jun	Unoccluded
3	18-Jun	Unoccluded
4	19-Jun	Unoccluded
4	20-Jun	Unoccluded
4	21-Jun	Unoccluded
4	22-Jun	Occluded
4	23-Jun	Occluded
4	24-Jun	Occluded
5	25-Jun	Unoccluded
5	26-Jun	Unoccluded
5	27-Jun	Unoccluded
5	28-Jun	Occluded
5	29-Jun	Occluded
5	30-Jun	Occluded
6	1-Jul	Unoccluded
6	2-Jul	Unoccluded
6	3-Jul	Unoccluded
6	4-Jul	Occluded
6	5-Jul	Occluded
6	6-Jul	Occluded

Appendix Q continued

7	7-Jul	Unoccluded
7	8-Jul	Unoccluded
7	9-Jul	Unoccluded
7	10-Jul	Occluded
7	11-Jul	Occluded
7	12-Jul	Occluded

Appendix R. Hourly spill discharge (Spill), total discharge (Totq), and percent spill discharge at The Dalles Dam by date, hour, block, and treatment, summer 2002. Discharge units are in thousand cubic feet per second. A "T" following the treatment indicates a transition period between treatments.

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
25 June	0800	5	UnoccludedT	105	274.6	38.2
25 June	0900	5	UnoccludedT	105	275.6	38.1
25 June	1000	5	UnoccludedT	105	276.9	37.9
25 June	1100	5	UnoccludedT	105	275.1	38.2
25 June	1200	5	Unoccluded	105	276.9	37.9
25 June	1300	5	Unoccluded	105	285.0	36.8
25 June	1400	5	Unoccluded	120	308.0	39.0
25 June	1500	5	Unoccluded	120	319.0	37.6
25 June	1600	5	Unoccluded	120	309.1	38.8
25 June	1700	5	Unoccluded	120	313.3	38.3
25 June	1800	5	Unoccluded	120	330.0	36.4
25 June	1900	5	Unoccluded	120	329.5	36.4
25 June	2000	5	Unoccluded	120	326.9	36.7
25 June	2100	5	Unoccluded	120	313.0	38.3
25 June	2200	5	Unoccluded	120	305.9	39.2
25 June	2300	5	Unoccluded	115	289.0	39.8
26 June	0000	5	Unoccluded	104	261.3	39.8
26 June	0100	5	Unoccluded	104	254.5	40.9
26 June	0200	5	Unoccluded	104	262.6	39.6
26 June	0300	5	Unoccluded	104	256.9	40.5
26 June	0400	5	Unoccluded	104	260.8	39.9
26 June	0500	5	Unoccluded	104	264.4	39.3
26 June	0600	5	Unoccluded	108	272.3	39.7
26 June	0700	5	Unoccluded	108	278.4	38.8
26 June	0800	5	Unoccluded	108	282.4	38.2
26 June	0900	5	Unoccluded	108	283.2	38.1
26 June	1000	5	Unoccluded	81	264.0	30.7
26 June	1100	5	Unoccluded	0	236.7	0.0
26 June	1200	5	Unoccluded	0	244.4	0.0
26 June	1300	5	Unoccluded	0	244.2	0.0
26 June	1400	5	Unoccluded	0	244.5	0.0
26 June	1500	5	Unoccluded	0	253.7	0.0

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
26 June	1600	5	Unoccluded	0	237.4	0.0
26 June	1700	5	Unoccluded	0	236.8	0.0
26 June	1800	5	Unoccluded	110	354.7	31.0
26 June	1900	5	Unoccluded	110	343.1	32.1
26 June	2000	5	Unoccluded	110	351.2	31.3
26 June	2100	5	Unoccluded	110	352.0	31.2
26 June	2200	5	Unoccluded	110	337.4	32.6
26 June	2300	5	Unoccluded	110	300.7	36.6
27 June	0000	5	Unoccluded	110	254.8	43.2
27 June	0100	5	Unoccluded	110	293.7	37.5
27 June	0200	5	Unoccluded	110	275.5	39.9
27 June	0300	5	Unoccluded	110	256.6	42.9
27 June	0400	5	Unoccluded	110	248.1	44.3
27 June	0500	5	Unoccluded	110	249.6	44.1
27 June	0600	5	Unoccluded	110	266.5	41.3
27 June	0700	5	Unoccluded	110	309.9	35.5
27 June	0800	5	Unoccluded	110	345.8	31.8
27 June	0900	5	Unoccluded	110	349.2	31.5
27 June	1000	5	Unoccluded	82	306.9	26.7
27 June	1100	5	Unoccluded	100	328.9	30.4
27 June	1200	5	Unoccluded	100	338.0	29.6
27 June	1300	5	Unoccluded	100	337.8	29.6
27 June	1400	5	Unoccluded	100	336.0	29.8
27 June	1500	5	Unoccluded	100	343.6	29.1
27 June	1600	5	Unoccluded	100	323.5	30.9
27 June	1700	5	Unoccluded	100	311.1	32.1
27 June	1800	5	Unoccluded	100	295.8	33.8
27 June	1900	5	Unoccluded	100	293.5	34.1
27 June	2000	5	Unoccluded	100	295.2	33.9
27 June	2100	5	Unoccluded	100	296.3	33.7
27 June	2200	5	Unoccluded	100	296.2	33.8
27 June	2300	5	Unoccluded	100	293.0	34.1
28 June	0000	5	Unoccluded	100	296.6	33.7
28 June	0100	5	Unoccluded	150	308.9	48.6
28 June	0200	5	Unoccluded	250	322.1	77.6

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
28 June	0300	5	Unoccluded	250	314.5	79.5
28 June	0400	5	Unoccluded	250	320.6	78.0
28 June	0500	5	Unoccluded	250	314.7	79.4
28 June	0600	5	Unoccluded	250	329.3	75.9
28 June	0700	5	Unoccluded	100	305.8	32.7
28 June	0800	5	OccludedT	0	235.6	0.0
28 June	0900	5	OccludedT	0	237.0	0.0
28 June	1000	5	OccludedT	68	286.4	23.7
28 June	1100	5	OccludedT	100	308.2	32.4
28 June	1200	5	Occluded	100	307.4	32.5
28 June	1300	5	Occluded	100	320.3	31.2
28 June	1400	5	Occluded	100	331.4	30.2
28 June	1500	5	Occluded	110	359.6	30.6
28 June	1600	5	Occluded	110	362.0	30.4
28 June	1700	5	Occluded	110	363.3	30.3
28 June	1800	5	Occluded	110	362.2	30.4
28 June	1900	5	Occluded	110	362.1	30.4
28 June	2000	5	Occluded	110	360.7	30.5
28 June	2100	5	Occluded	110	364.2	30.2
28 June	2200	5	Occluded	110	364.2	30.2
28 June	2300	5	Occluded	110	353.2	31.1
29 June	0000	5	Occluded	250	369.1	67.7
29 June	0100	5	Occluded	250	364.8	68.5
29 June	0200	5	Occluded	250	364.3	68.6
29 June	0300	5	Occluded	250	365.4	68.4
29 June	0400	5	Occluded	250	367.2	68.1
29 June	0500	5	Occluded	250	363.8	68.7
29 June	0600	5	Occluded	250	364.1	68.7
29 June	0700	5	Occluded	250	364.1	68.7
29 June	0800	5	Occluded	250	376.1	66.5
29 June	0900	5	Occluded	190	376.8	50.4
29 June	1000	5	Occluded	170	378.4	44.9
29 June	1100	5	Occluded	145	372.6	38.9
29 June	1200	5	Occluded	150	371.3	40.4
29 June	1300	5	Occluded	150	372.0	40.3

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
29 June	1400	5	Occluded	120	341.4	35.1
29 June	1500	5	Occluded	120	336.5	35.7
29 June	1600	5	Occluded	120	340.8	35.2
29 June	1700	5	Occluded	120	341.9	35.1
29 June	1800	5	Occluded	120	347.3	34.6
29 June	1900	5	Occluded	100	338.3	29.6
29 June	2000	5	Occluded	100	337.1	29.7
29 June	2100	5	Occluded	95	328.4	28.9
29 June	2200	5	Occluded	95	326.0	29.1
29 June	2300	5	Occluded	95	339.8	28.0
30 June	0000	5	Occluded	95	318.3	29.8
30 June	0100	5	Occluded	95	304.4	31.2
30 June	0200	5	Occluded	95	285.3	33.3
30 June	0300	5	Occluded	95	263.4	36.1
30 June	0400	5	Occluded	95	268.2	35.4
30 June	0500	5	Occluded	95	261.7	36.3
30 June	0600	5	Occluded	95	261.1	36.4
30 June	0700	5	Occluded	95	267.0	35.6
30 June	0800	5	Occluded	100	293.5	34.1
30 June	0900	5	Occluded	100	314.8	31.8
30 June	1000	5	Occluded	100	316.0	31.6
30 June	1100	5	Occluded	100	314.8	31.8
30 June	1200	5	Occluded	100	315.9	31.7
30 June	1300	5	Occluded	100	314.1	31.8
30 June	1400	5	Occluded	100	314.9	31.8
30 June	1500	5	Occluded	100	320.2	31.2
30 June	1600	5	Occluded	100	323.8	30.9
30 June	1700	5	Occluded	100	302.5	33.1
30 June	1800	5	Occluded	100	294.2	34.0
30 June	1900	5	Occluded	100	291.5	34.3
30 June	2000	5	Occluded	100	291.7	34.3
30 June	2100	5	Occluded	100	291.6	34.3
30 June	2200	5	Occluded	100	285.0	35.1
30 June	2300	5	Occluded	100	262.2	38.1
1 July	0000	5	Occluded	100	249.4	40.1

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
1 July	0100	5	Occluded	92	226.8	40.6
1 July	0200	5	Occluded	180	258.7	69.6
1 July	0300	5	Occluded	180	256.0	70.3
1 July	0400	5	Occluded	200	262.3	76.2
1 July	0500	5	Occluded	200	259.4	77.1
1 July	0600	5	Occluded	200	262.1	76.3
1 July	0700	5	Occluded	100	246.6	40.6
1 July	0800	6	UnoccludedT	250	317.7	78.7
1 July	0900	6	UnoccludedT	250	340.6	73.4
1 July	1000	6	UnoccludedT	250	368.1	67.9
1 July	1100	6	UnoccludedT	250	393.3	63.6
1 July	1200	6	Unoccluded	250	422.1	59.2
1 July	1300	6	Unoccluded	250	466.5	53.6
1 July	1400	6	Unoccluded	250	418.8	59.7
1 July	1500	6	Unoccluded	250	409.9	61.0
1 July	1600	6	Unoccluded	150	369.1	40.6
1 July	1700	6	Unoccluded	150	326.7	45.9
1 July	1800	6	Unoccluded	100	288.5	34.7
1 July	1900	6	Unoccluded	100	291.9	34.3
1 July	2000	6	Unoccluded	100	292.1	34.2
1 July	2100	6	Unoccluded	100	289.5	34.5
1 July	2200	6	Unoccluded	100	286.6	34.9
1 July	2300	6	Unoccluded	100	278.2	35.9
2 July	0000	6	Unoccluded	100	261.7	38.2
2 July	0100	6	Unoccluded	100	266.9	37.5
2 July	0200	6	Unoccluded	100	243.9	41.0
2 July	0300	6	Unoccluded	200	266.0	75.2
2 July	0400	6	Unoccluded	200	262.1	76.3
2 July	0500	6	Unoccluded	200	258.3	77.4
2 July	0600	6	Unoccluded	200	257.8	77.6
2 July	0700	6	Unoccluded	200	265.1	75.4
2 July	0800	6	Unoccluded	135	282.2	47.8
2 July	0900	6	Unoccluded	100	330.1	30.3
2 July	1000	6	Unoccluded	100	339.1	29.5
2 July	1100	6	Unoccluded	100	342.1	29.2

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
2 July	1200	6	Unoccluded	100	338.7	29.5
2 July	1300	6	Unoccluded	100	322.3	31.0
2 July	1400	6	Unoccluded	160	381.4	42.0
2 July	1500	6	Unoccluded	100	353.4	28.3
2 July	1600	6	Unoccluded	100	339.0	29.5
2 July	1700	6	Unoccluded	100	341.2	29.3
2 July	1800	6	Unoccluded	100	341.6	29.3
2 July	1900	6	Unoccluded	100	342.0	29.2
2 July	2000	6	Unoccluded	100	341.1	29.3
2 July	2100	6	Unoccluded	100	345.9	28.9
2 July	2200	6	Unoccluded	100	344.8	29.0
2 July	2300	6	Unoccluded	100	344.2	29.1
3 July	0000	6	Unoccluded	120	325.1	36.9
3 July	0100	6	Unoccluded	120	313.5	38.3
3 July	0200	6	Unoccluded	120	298.0	40.3
3 July	0300	6	Unoccluded	200	306.8	65.2
3 July	0400	6	Unoccluded	200	301.1	66.4
3 July	0500	6	Unoccluded	225	291.7	77.1
3 July	0600	6	Unoccluded	150	283.3	52.9
3 July	0700	6	Unoccluded	100	277.3	36.1
3 July	0800	6	Unoccluded	100	284.3	35.2
3 July	0900	6	Unoccluded	100	280.3	35.7
3 July	1000	6	Unoccluded	100	310.3	32.2
3 July	1100	6	Unoccluded	100	301.1	33.2
3 July	1200	6	Unoccluded	100	313.4	31.9
3 July	1300	6	Unoccluded	100	294.0	34.0
3 July	1400	6	Unoccluded	100	297.4	33.6
3 July	1500	6	Unoccluded	100	312.7	32.0
3 July	1600	6	Unoccluded	100	278.6	35.9
3 July	1700	6	Unoccluded	100	293.7	34.0
3 July	1800	6	Unoccluded	100	307.0	32.6
3 July	1900	6	Unoccluded	100	342.4	29.2
3 July	2000	6	Unoccluded	100	345.1	29.0
3 July	2100	6	Unoccluded	100	328.9	30.4
3 July	2200	6	Unoccluded	100	329.8	30.3

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
3 July	2300	6	Unoccluded	100	301.3	33.2
4 July	0000	6	Unoccluded	100	287.5	34.8
4 July	0100	6	Unoccluded	100	314.3	31.8
4 July	0200	6	Unoccluded	100	306.9	32.6
4 July	0300	6	Unoccluded	100	304.6	32.8
4 July	0400	6	Unoccluded	100	308.6	32.4
4 July	0500	6	Unoccluded	100	305.0	32.8
4 July	0600	6	Unoccluded	100	304.6	32.8
4 July	0700	6	Unoccluded	100	312.2	32.0
4 July	0800	6	OccludedT	100	323.1	31.0
4 July	0900	6	OccludedT	100	325.6	30.7
4 July	1000	6	OccludedT	100	324.6	30.8
4 July	1100	6	OccludedT	100	329.6	30.3
4 July	1200	6	Occluded	100	324.6	30.8
4 July	1300	6	Occluded	100	313.9	31.9
4 July	1400	6	Occluded	100	305.4	32.7
4 July	1500	6	Occluded	100	306.3	32.6
4 July	1600	6	Occluded	100	286.8	34.9
4 July	1700	6	Occluded	100	284.5	35.1
4 July	1800	6	Occluded	100	304.5	32.8
4 July	1900	6	Occluded	100	322.5	31.0
4 July	2000	6	Occluded	100	318.6	31.4
4 July	2100	6	Occluded	100	322.4	31.0
4 July	2200	6	Occluded	100	324.2	30.8
4 July	2300	6	Occluded	100	317.9	31.5
5 July	0000	6	Occluded	100	0200.7	49.8
5 July	0100	6	Occluded	96	231.6	41.5
5 July	0200	6	Occluded	96	230.9	41.6
5 July	0300	6	Occluded	96	237.2	40.5
5 July	0400	6	Occluded	96	230.8	41.6
5 July	0500	6	Occluded	96	227.9	42.1
5 July	0600	6	Occluded	96	228.4	42.0
5 July	0700	6	Occluded	96	243.3	39.5
5 July	0800	6	Occluded	100	249.9	40.0
5 July	0900	6	Occluded	100	251.1	39.8

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
5 July	1000	6	Occluded	100	269.5	37.1
5 July	1100	6	Occluded	100	294.2	34.0
5 July	1200	6	Occluded	100	290.7	34.4
5 July	1300	6	Occluded	100	272.6	36.7
5 July	1400	6	Occluded	100	282.2	35.4
5 July	1500	6	Occluded	100	295.0	33.9
5 July	1600	6	Occluded	110	283.5	38.8
5 July	1700	6	Occluded	110	280.6	39.2
5 July	1800	6	Occluded	110	280.3	39.2
5 July	1900	6	Occluded	104	272.8	38.1
5 July	2000	6	Occluded	104	257.0	40.5
5 July	2100	6	Occluded	104	255.7	40.7
5 July	2200	6	Occluded	104	254.6	40.8
5 July	2300	6	Occluded	104	264.8	39.3
6 July	0000	6	Occluded	104	249.5	41.7
6 July	0100	6	Occluded	104	240.5	43.2
6 July	0200	6	Occluded	80	200.2	40.0
6 July	0300	6	Occluded	80	231.1	34.6
6 July	0400	6	Occluded	80	201.2	39.8
6 July	0500	6	Occluded	80	200.6	39.9
6 July	0600	6	Occluded	80	200.4	39.9
6 July	0700	6	Occluded	80	204.1	39.2
6 July	0800	6	Occluded	80	206.0	38.8
6 July	0900	6	Occluded	80	211.1	37.9
6 July	1000	6	Occluded	100	256.7	39.0
6 July	1100	6	Occluded	100	260.5	38.4
6 July	1200	6	Occluded	110	282.7	38.9
6 July	1300	6	Occluded	110	312.2	35.2
6 July	1400	6	Occluded	110	308.4	35.7
6 July	1500	6	Occluded	110	317.1	34.7
6 July	1600	6	Occluded	110	293.1	37.5
6 July	1700	6	Occluded	110	294.3	37.4
6 July	1800	6	Occluded	110	310.0	35.5
6 July	1900	6	Occluded	110	315.9	34.8
6 July	2000	6	Occluded	110	281.3	39.1

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
6 July	2100	6	Occluded	110	282.9	38.9
6 July	2200	6	Occluded	110	279.7	39.3
6 July	2300	6	Occluded	110	277.5	39.6
7 July	0000	6	Occluded	110	264.4	41.6
7 July	0100	6	Occluded	88	214.2	41.1
7 July	0200	6	Occluded	88	218.9	40.2
7 July	0300	6	Occluded	88	227.0	38.8
7 July	0400	6	Occluded	80	190.2	42.1
7 July	0500	6	Occluded	72	178.6	40.3
7 July	0600	6	Occluded	72	174.9	41.2
7 July	0700	6	Occluded	60	165.0	36.4
7 July	0800	7	UnoccludedT	60	153.9	39.0
7 July	0900	7	UnoccludedT	60	154.6	38.8
7 July	1000	7	UnoccludedT	84	209.4	40.1
7 July	1100	7	UnoccludedT	84	218.4	38.5
7 July	1200	7	Unoccluded	84	216.9	38.7
7 July	1300	7	Unoccluded	96	250.0	38.4
7 July	1400	7	Unoccluded	96	248.6	38.6
7 July	1500	7	Unoccluded	96	267.5	35.9
7 July	1600	7	Unoccluded	96	252.6	38.0
7 July	1700	7	Unoccluded	96	255.0	37.6
7 July	1800	7	Unoccluded	96	290.1	33.1
7 July	1900	7	Unoccluded	96	299.7	32.0
7 July	2000	7	Unoccluded	96	292.5	32.8
7 July	2100	7	Unoccluded	96	297.3	32.3
7 July	2200	7	Unoccluded	96	296.6	32.4
7 July	2300	7	Unoccluded	96	280.7	34.2
8 July	0000	7	Unoccluded	96	277.9	34.5
8 July	0100	7	Unoccluded	96	232.2	41.3
8 July	0200	7	Unoccluded	96	227.0	42.3
8 July	0300	7	Unoccluded	80	224.0	35.7
8 July	0400	7	Unoccluded	80	200.0	40.0
8 July	0500	7	Unoccluded	80	195.1	41.0
8 July	0600	7	Unoccluded	72	179.9	40.0
8 July	0700	7	Unoccluded	72	188.4	38.2

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
8 July	0800	7	Unoccluded	80	200.7	39.9
8 July	0900	7	Unoccluded	80	203.4	39.3
8 July	1000	7	Unoccluded	88	223.0	39.5
8 July	1100	7	Unoccluded	88	225.2	39.1
8 July	1200	7	Unoccluded	88	226.1	38.9
8 July	1300	7	Unoccluded	88	222.5	39.6
8 July	1400	7	Unoccluded	88	228.0	38.6
8 July	1500	7	Unoccluded	88	233.4	37.7
8 July	1600	7	Unoccluded	88	222.5	39.6
8 July	1700	7	Unoccluded	90	235.9	38.2
8 July	1800	7	Unoccluded	90	249.2	36.1
8 July	1900	7	Unoccluded	90	255.1	35.3
8 July	2000	7	Unoccluded	90	254.7	35.3
8 July	2100	7	Unoccluded	90	256.4	35.1
8 July	2200	7	Unoccluded	90	255.1	35.3
8 July	2300	7	Unoccluded	90	250.8	35.9
9 July	0000	7	Unoccluded	90	235.0	38.3
9 July	0100	7	Unoccluded	90	212.0	42.5
9 July	0200	7	Unoccluded	76	183.9	41.3
9 July	0300	7	Unoccluded	68	185.2	36.7
9 July	0400	7	Unoccluded	60	147.5	40.7
9 July	0500	7	Unoccluded	60	141.4	42.4
9 July	0600	7	Unoccluded	60	151.9	39.5
9 July	0700	7	Unoccluded	64	168.0	38.1
9 July	0800	7	Unoccluded	68	176.5	38.5
9 July	0900	7	Unoccluded	77	201.9	38.1
9 July	1000	7	Unoccluded	77	203.3	37.9
9 July	1100	7	Unoccluded	77	205.3	37.5
9 July	1200	7	Unoccluded	83	218.3	38.0
9 July	1300	7	Unoccluded	83	216.5	38.3
9 July	1400	7	Unoccluded	87	241.3	36.1
9 July	1500	7	Unoccluded	100	282.8	35.4
9 July	1600	7	Unoccluded	100	264.8	37.8
9 July	1700	7	Unoccluded	100	259.0	38.6
9 July	1800	7	Unoccluded	100	267.7	37.4

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
9 July	1900	7	Unoccluded	96	276.9	34.7
9 July	2000	7	Unoccluded	96	279.5	34.3
9 July	2100	7	Unoccluded	96	249.3	38.5
9 July	2200	7	Unoccluded	90	224.5	40.1
9 July	2300	7	Unoccluded	72	176.3	40.8
10 July	0000	7	Unoccluded	72	166.8	43.2
10 July	0100	7	Unoccluded	68	163.1	41.7
10 July	0200	7	Unoccluded	68	155.0	43.9
10 July	0300	7	Unoccluded	56	154.7	36.2
10 July	0400	7	Unoccluded	56	134.9	41.5
10 July	0500	7	Unoccluded	56	137.5	40.7
10 July	0600	7	Unoccluded	56	141.0	39.7
10 July	0700	7	Unoccluded	56	143.1	39.1
10 July	0800	7	OccludedT	56	133.7	41.9
10 July	0900	7	OccludedT	56	142.7	39.2
10 July	1000	7	OccludedT	78	198.0	39.4
10 July	1100	7	OccludedT	78	209.8	37.2
10 July	1200	7	Occluded	78	201.0	38.8
10 July	1300	7	Occluded	86	217.2	39.6
10 July	1400	7	Occluded	91	239.7	38.0
10 July	1500	7	Occluded	107	279.8	38.2
10 July	1600	7	Occluded	110	286.0	38.5
10 July	1700	7	Occluded	110	307.5	35.8
10 July	1800	7	Occluded	110	349.0	31.5
10 July	1900	7	Occluded	110	257.4	42.7
10 July	2000	7	Occluded	100	264.1	37.9
10 July	2100	7	Occluded	92	239.6	38.4
10 July	2200	7	Occluded	92	228.0	40.4
10 July	2300	7	Occluded	82	209.1	39.2
11 July	0000	7	Occluded	72	173.5	41.5
11 July	0100	7	Occluded	62	148.5	41.8
11 July	0200	7	Occluded	62	153.1	40.5
11 July	0300	7	Occluded	62	167.3	37.1
11 July	0400	7	Occluded	62	151.4	41.0
11 July	0500	7	Occluded	62	156.6	39.6

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
11 July	0600	7	Occluded	62	159.4	38.9
11 July	0700	7	Occluded	62	162.9	38.1
11 July	0800	7	Occluded	62	167.6	37.0
11 July	0900	7	Occluded	62	159.6	38.8
11 July	1000	7	Occluded	62	155.4	39.9
11 July	1100	7	Occluded	62	154.5	40.1
11 July	1200	7	Occluded	62	158.5	39.1
11 July	1300	7	Occluded	86	213.2	40.3
11 July	1400	7	Occluded	110	284.4	38.7
11 July	1500	7	Occluded	110	321.6	34.2
11 July	1600	7	Occluded	110	342.2	32.1
11 July	1700	7	Occluded	110	337.9	32.6
11 July	1800	7	Occluded	110	328.7	33.5
11 July	1900	7	Occluded	110	321.8	34.2
11 July	2000	7	Occluded	110	332.4	33.1
11 July	2100	7	Occluded	110	307.1	35.8
11 July	2200	7	Occluded	110	304.6	36.1
11 July	2300	7	Occluded	110	319.7	34.4
12 July	0000	7	Occluded	110	280.8	39.2
12 July	0100	7	Occluded	95	238.9	39.8
12 July	0200	7	Occluded	80	199.7	40.1
12 July	0300	7	Occluded	65	166.3	39.1
12 July	0400	7	Occluded	65	159.2	40.8
12 July	0500	7	Occluded	65	160.1	40.6
12 July	0600	7	Occluded	65	164.1	39.6
12 July	0700	7	Occluded	65	158.4	41.0
12 July	0800	7	Occluded	65	165.4	39.3
12 July	0900	7	Occluded	65	172.6	37.7
12 July	1000	7	Occluded	65	185.8	35.0
12 July	1100	7	Occluded	80	198.8	40.2
12 July	1200	7	Occluded	100	251.1	39.8
12 July	1300	7	Occluded	110	282.8	38.9
12 July	1400	7	Occluded	110	299.6	36.7
12 July	1500	7	Occluded	105	334.4	31.4
12 July	1600	7	Occluded	105	341.6	30.7

Appendix R continued

Date	Hour	Block	Treatment	Spill	Totq	Percent spill
12 July	1700	7	Occluded	105	339.9	30.9
12 July	1800	7	Occluded	105	338.9	31.0
12 July	1900	7	Occluded	105	329.0	31.9
12 July	2000	7	Occluded	105	322.7	32.5
12 July	2100	7	Occluded	105	319.2	32.9
12 July	2200	7	Occluded	105	298.8	35.1
12 July	2300	7	Occluded	105	297.7	35.3
13 July	0000	7	Occluded	105	296.9	35.4
13 July	0100	7	Occluded	105	269.9	38.9
13 July	0200	7	Occluded	92	241.8	38.0
13 July	0300	7	Occluded	80	210.0	38.1
13 July	0400	7	Occluded	80	200.0	40.0
13 July	0500	7	Occluded	80	198.6	40.3
13 July	0600	7	Occluded	80	196.8	40.7
13 July	0700	7	Occluded	80	192.1	41.6

Appendix S. Fork lengths and weights of subyearling Chinook salmon released at Rock Creek during summer 2002.

Release Date	Release Time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
6/24/02	2100	52	113.5	2.9	110-124	15.6	1.3	13.3-20.7
6/25/02	0900	59	115.3	4.1	111-128	16.9	2.2	12.8-20.9
6/25/02	2100	65	113.8	3.1	110-122	16.9	1.6	13.8-22.2
6/26/02	0900	62	113.0	2.8	110-123	15.7	1.4	13.0-19.4
6/26/02	2100	58	114.1	3.1	110-126	16.0	1.9	12.5-23.8
6/27/02	0900	61	113.0	2.4	110-121	15.2	1.4	13.1-20.3
6/27/02	2100	60	114.6	3.5	110-126	15.5	1.6	13.0-20.9
6/28/02	0900	61	114.2	3.8	110-128	17.0	1.9	14.0-23.3
6/28/02	2100	53	113.6	2.6	110-120	15.4	1.3	13.5-19.1
6/29/02	0900	64	114.5	4.2	110-132	16.4	2.5	11.9-25.7
6/29/02	2100	54	114.1	4.9	110-137	17.1	2.4	14.3-28.8
6/30/02	0900	55	112.9	5.0	110-143	15.5	3.0	12.7-32.6
6/30/02	2100	58	113.8	4.7	110-134	15.1	1.9	12.1-23.0
7/01/02	0900	59	112.1	2.5	110-119	14.9	1.2	12.9-18.1
7/01/02	2100	37	114.0	7.0	110-149	16.1	3.9	12.9-35.7
7/02/02	0900	50	112.7	3.0	110-125	15.2	1.6	13.2-21.2
7/02/02	2100	42	114.3	3.7	110-128	17.8	2.1	14.1-22.3
7/03/02	0900	32	114.6	4.6	110-125	16.4	2.4	12.4-21.3
7/03/02	2100	41	114.3	3.5	110-126	15.3	1.6	13.0-20.6
7/04/02	0900	29	115.0	6.2	110-143	17.3	3.1	13.5-31.4
7/04/02	2100	41	113.9	4.4	110-136	15.3	2.2	12.3-25.7
7/05/02	0900	41	114.5	5.7	110-135	15.9	2.6	13.1-25.6
7/05/02	2100	40	115.2	6.3	110-145	17.9	3.4	14.5-34.1
7/06/02	0900	41	115.3	5.8	110-141	16.0	2.8	12.9-28.6
7/06/02	2100	45	114.2	5.2	110-138	16.2	3.1	11.6-30.3
7/07/02	0900	40	115.7	6.4	110-136	17.7	3.2	14.1-26.5
7/07/02	2100	38	114.4	6.2	110-145	15.8	3.2	13.2-31.3
7/08/02	2100	33	114.7	5.5	110-135	17.0	2.9	14.1-29.2
7/08/02	2100	59	116.0	7.7	110-149	18.5	3.8	15.0-34.3
7/09/02	0900	44	116.5	7.2	110-151	16.5	3.5	13.1-34.4
7/09/02	2100	39	116.7	6.1	110-137	17.9	3.5	13.4-29.4
7/10/02	0900	38	118.7	8.6	110-146	18.3	4.3	13.0-33.3
7/10/02	2100	46	117.0	6.6	111-140	17.3	3.6	13.8-31.3
7/11/02	0900	43	117.8	7.8	110-148	19.9	4.8	14.9-37.4
7/11/02	2100	46	115.7	6.0	110-138	17.3	3.2	13.9-29.6

Appendix S continued

Release Date	Release Time	N	Fork length (mm) Mean	SD	Range	Weight (g) Mean	SD	Range
7/12/02	0900	49	114.0	4.5	110-128	16.1	2.3	13.3-22.6
7/12/02	2100	44	116.5	6.2	110-133	18.0	3.0	13.9-25.5
Overall		1779	116.5	6.8	110-151	17.6	3.7	11.6-37.4

Appendix T. Fork lengths and weights of subyearling Chinook salmon released into the John Day Dam juvenile bypass during spring 2002.

Release Date	Release time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
6/21/02	2300	52	116	4.8	110-132	16.7	2.5	13.6-25.7
6/22/02	2300	48	114	3.8	108-128	14.9	1.8	12.7-22.3
6/24/02	2300	54	116	3.7	110-126	16.0	1.6	13.1-20.5
6/25/02	2300	57	115	4.2	110-139	16.1	2.1	14.0-27.9
6/25/02	2300	49	114	2.9	110-122	15.3	1.5	13.1-18.7
6/26/02	2300	53	115	3.9	110-132	16.7	2.1	14.0-26.9
6/27/02	2300	52	115	5.1	110-135	15.6	2.4	12.7-25.3
6/28/02	2300	60	114	3.1	110-130	16.0	1.5	13.7-24.5
6/29/02	2300	48	113	2.7	110-120	15.2	1.4	13.1-19.2
6/30/02	2300	48	113	3.9	109-128	16.2	2.1	13.4-23.1
7/01/02	2300	49	113	3.2	110-124	15.1	1.7	13.1-21.4
7/02/02	2300	34	113	3.1	110-122	16.0	1.6	13.7-21.3
7/03/02	2300	35	114	3.5	110-121	15.5	1.9	13.0-20.3
7/04/02	2300	49	118	9.4	108-145	17.9	4.7	13.1-30.1
7/05/02	2300	58	116	6.1	110-142	16.5	3.0	13.1-31.2
7/06/02	2300	40	116	7.7	109-142	16.9	5.8	13.0-46.7
7/07/02	2300	53	116	8.0	110-142	17.4	4.1	13.0-31.1
7/08/02	2300	44	119	8.6	110-140	19.1	4.0	13.4-28.8
7/09/02	2300	39	118	8.4	110-142	17.7	4.0	13.4-28.6
7/10/02	2300	38	117	4.9	110-133	18.2	2.9	14.6-29.0
7/11/02	2300	39	117	5.2	110-128	17.2	3.0	13.8-25.2
7/12/02	2300	35	117	8.2	110-140	18.6	4.3	13.3-28.9
Overall		1034	117	6.0	108-145	17.2	3.1	12.7-46.7

Appendix U. Fork lengths and weights of subyearling Chinook salmon released into the John Day Dam tailrace during spring 2002.

Release Date	Release time	N	Fork length (mm)			Weight (g)		
			Mean	SD	Range	Mean	SD	Range
6/21/02	2300	60	116	5.2	110-131	16.7	2.5	14.0-24.2
6/22/02	2300	60	114	5.0	108-132	16.0	5.2	12.6-30.8
6/24/02	2300	53	115	3.7	110-125	15.4	1.3	13.1-20.4
6/25/02	2300	52	115	3.5	111-125	16.8	1.9	14.4-22.8
6/25/02	1100	59	117	4.7	111-132	16.0	2.2	13.3-22.9
6/25/02	2300	59	115	4.1	110-131	15.7	2.1	13.2-24.0
6/26/02	1100	45	113	2.9	110-123	15.1	1.3	13.1-18.7
6/26/02	2300	56	115	3.0	110-121	16.3	1.5	13.6-21.1
6/27/02	1100	48	115	3.4	110-125	15.8	1.6	13.0-20.2
6/27/02	2300	59	115	5.1	110-137	15.6	2.4	13.0-29.0
6/28/02	1100	46	113	3.3	110-123	16.4	1.7	14.0-21.1
6/28/02	2300	60	114	3.7	110-125	16.4	1.9	13.2-21.1
6/29/02	1100	51	114	2.8	110-123	15.2	1.2	13.5-19.0
6/29/02	2300	50	113	2.6	110-124	15.2	1.3	13.0-20.6
6/30/02	1100	53	113	2.6	110-121	15.6	1.4	13.3-19.3
6/30/02	2300	49	113	5.3	109-135	16.4	3.0	13.3-28.0
7/01/02	1100	48	113	2.5	110-120	14.9	1.3	13.0-18.7
7/01/02	2300	50	114	4.3	110-131	15.4	2.1	13.0-23.2
7/02/02	1100	44	114	6.1	110-138	16.3	3.2	14.0-29.5
7/02/02	2300	40	115	4.7	110-127	16.9	2.6	13.2-23.7
7/03/02	1100	32	113	3.5	107-121	14.9	1.6	13.0-19.9
7/03/02	2300	46	114	4.3	110-130	15.8	2.2	13.2-22.6
7/04/02	1100	38	113	2.8	110-120	15.6	1.3	13.4-18.1
7/04/02	2300	53	116	7.4	109-144	17.1	4.0	13.4-35.0
7/05/02	1100	41	116	6.9	110-143	16.4	3.5	13.0-29.8
7/05/02	2300	57	116	6.5	110-138	16.7	3.2	13.1-26.6
7/06/02	1100	35	117	7.4	110-137	17.3	3.4	13.8-27.5
7/06/02	2300	43	117	5.9	109-133	16.9	3.0	13.6-25.3
7/07/02	1100	31	116	8.8	110-145	17.3	4.1	13.1-30.6
7/07/02	2300	59	116	5.9	110-138	17.0	3.0	14.1-29.2
7/08/02	1100	34	117	7.1	110-140	17.1	3.4	14.2-29.0
7/08/02	2300	48	115	6.4	109-135	17.2	3.2	13.8-27.8
7/09/02	1100	40	117	7.5	110-147	16.9	3.7	13.4-32.0
7/09/02	2300	42	120	9.2	110-142	18.5	4.6	13.5-30.1
7/10/02	1100	44	118	7.6	110-137	18.2	3.5	14.4-27.3
7/10/02	2300	43	120	8.2	110-141	19.4	4.2	14.1-29.4

Appendix U continued

Release Date	Release Time	N	Fork length (mm) Mean	SD	Range	Weight (g) Mean	SD	Range
7/11/02	1100	42	117	4.8	111-133	17.2	2.7	13.8-25.7
7/11/02	2300	43	114	4.7	110-131	16.5	2.4	14.0-26.2
7/12/02	1100	39	116	6.1	110-135	16.8	3.2	12.8-29.8
7/12/02	2300	44	118	7.8	110-140	18.9	4.5	14.6-34.8
Overall		1896	117	6.1	107-147	17.2	3.0	12.6-35.0

Appendix V. Passage routes of subyearling Chinook salmon detected at main turbine units 1 through 4 at The Dalles Dam by block, treatment, diel, and date, summer 2002. Day=0530 to 2059 hours, Night=2100 to 0529 hours.

Species	Block	Treatment	Diel	Date	Turbines	Sluiceway	Spillway
CH0	5	Occluded	Day	28 June	7	12	12
CH0	5	Occluded	Day	29 June	7	9	20
CH0	5	Occluded	Day	30 June	19	9	25
CH0	5	Occluded	Day	1 July	0	1	1
CH0	5	Occluded	Night	28 June	1	6	1
CH0	5	Occluded	Night	29 June	0	3	0
CH0	5	Occluded	Night	30 June	1	6	0
CH0	5	Occluded	Night	1 July	2	1	2
CH0	5	Unoccluded	Day	25 June	27	3	1
CH0	5	Unoccluded	Day	26 June	38	4	6
CH0	5	Unoccluded	Day	27 June	25	8	17
CH0	5	Unoccluded	Day	28 June	0	5	1
CH0	5	Unoccluded	Night	25 June	4	2	0
CH0	5	Unoccluded	Night	26 June	8	3	0
CH0	5	Unoccluded	Night	27 June	9	9	0
CH0	5	Unoccluded	Night	28 June	11	1	1
CH0	6	Occluded	Day	4 July	0	14	0
CH0	6	Occluded	Day	5 July	12	10	13
CH0	6	Occluded	Day	6 July	17	7	14
CH0	6	Occluded	Day	7 July	1	1	2
CH0	6	Occluded	Night	5 July	5	3	1
CH0	6	Occluded	Night	6 July	2	7	2
CH0	6	Occluded	Night	7 July	2	1	0
CH0	6	Unoccluded	Day	1 July	13	2	19
CH0	6	Unoccluded	Day	2 July	28	12	10
CH0	6	Unoccluded	Day	3 July	27	9	16
CH0	6	Unoccluded	Day	4 July	0	3	0
CH0	6	Unoccluded	Night	2 July	9	5	2
CH0	6	Unoccluded	Night	3 July	4	3	1
CH0	7	Occluded	Day	10 July	8	3	10
CH0	7	Occluded	Day	11 July	13	11	21
CH0	7	Occluded	Day	12 July	12	10	17

Appendix V continued

Species	Block	Treatment	Diel	Date	Turbines	Sluiceway	Spillway
CH0	7	Occluded	Day	13 July	0	2	1
CH0	7	Occluded	Night	10 July	0	2	1
CH0	7	Occluded	Night	11 July	1	9	5
CH0	7	Occluded	Night	12 July	1	3	3
CH0	7	Occluded	Night	13 July	5	2	2
CH0	7	Unoccluded	Day	7 July	15	15	5
CH0	7	Unoccluded	Day	8 July	29	10	4
CH0	7	Unoccluded	Day	9 July	33	9	4
CH0	7	Unoccluded	Day	10 July	1	1	1
CH0	7	Unoccluded	Night	7 July	3	3	0
CH0	7	Unoccluded	Night	8 July	8	2	0
CH0	7	Unoccluded	Night	9 July	4	5	0
CH0	7	Unoccluded	Night	10 July	6	1	0

Appendix W. Estimates of subyearling Chinook salmon fish passage efficiency (FPE) for those detected within 10 m of main turbine unit 1 through main turbine unit 4 during occluded and unoccluded treatments at The Dalles Dam, 25 June through 13 July 2002. Day is defined, as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed
Block	FPE	N	Odds	FPE	N	Odds	Odds Ratio
5	72.9	122	2.690	33.3	135	0.499	0.185
6	67.0	91	2.030	51.1	139	1.045	0.515
7	70.1	107	2.344	38.6	127	0.629	0.268
Overall odds ratio adjusted for Blocks 5-7 (95%LRCI)						0.288(0.159-0.510)	
Test HO: odds ratio=1 (no treatment effect), P<0.0001.							

Night							
	Occluded			Unoccluded			Observed
Block	FPE	N	Odds	FPE	N	Odds	Odds Ratio
5	82.6	23	4.747	33.3	48	0.499	0.105
6	60.9	23	1.558	45.8	24	0.845	0.542
7	79.4	34	3.854	34.4	32	0.524	0.141
Overall odds ratio adjusted for Blocks 5-7 (95%LRCI)						0.191(0.097-0.363)	
Test HO: odds ratio=1 (no treatment effect), P<0.0001.							

Appendix X. Estimates of subyearling Chinook salmon spill passage efficiency (SPE) during occluded and unoccluded treatments at The Dalles Dam, 25 June through 13 July 2002. Day is defined, as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed Odds Ratio
Block	SPE	N	Odds	SPE	N	Odds	
5	47.5	122	0.905	18.5	135	0.227	0.251
6	31.9	91	0.468	32.4	139	0.479	1.023
7	45.8	107	0.845	11.0	127	0.124	0.147
Overall odds ratio adjusted for Blocks 5-7 (95%LRCI)						0.354(0.113-1.042)	
Test HO: odds ratio=1 (no treatment effect), P=0.060.							

Night							
	Occluded			Unoccluded			Observed Odds Ratio
Block	SPE	N	Odds	SPE	N	Odds	
5	13.0	23	0.149	2.1	48	0.021	0.141
6	13.0	23	0.149	12.5	24	0.143	0.960
7	32.3	34	0.477	0.0	32	0.000	0.000
Overall odds ratio adjusted for Blocks 5-7 (95%LRCI)						0.166(0.008-1.253)	
Test HO: odds ratio=1 (no treatment effect), P=0.084.							

Appendix Y. Estimates of subyearling Chinook salmon sluiceway passage efficiency (SLPE) during occluded and unoccluded treatments at The Dalles Dam, 25 June through 13 July 2002. Day is defined, as 0530 to 2059 hours and night is 2100 to 0529 hours.

Day							
	Occluded			Unoccluded			Observed
Block	SLPE	N	Odds	SLPE	N	Odds	Odds Ratio
5	25.4	122	0.340	14.8	135	0.174	0.512
6	35.2	91	0.543	18.7	139	0.230	0.424
7	24.3	107	0.321	27.6	127	0.381	1.187
Overall odds ratio adjusted for Blocks 5-7 (95%LRCI)						0.646(0.343-1.209)	
Test HO: odds ratio=1 (no treatment effect), P=0.171.							

Night							
	Occluded			Unoccluded			Observed
Block	SLPE	N	Odds	SLPE	N	Odds	Odds Ratio
5	69.6	23	2.289	33.3	48	0.499	0.218
6	31.2	23	0.453	47.1	24	0.890	1.965
7	47.8	34	0.915	34.4	32	0.524	0.573
Overall odds ratio adjusted for Blocks 5-7 (95%LRCI)						0.395(0.211-0.726)	
Test HO: odds ratio=1 (no treatment effect), P<0.003.							